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Amphibians from Sabah I.
Systematic and Natural History Notes*

Masafumi MATSUI

Abstract

Thirty-two species, including two questionable and three unidentified forms, of anuran amphibians from Sabah, Northern Borneo, are reported with special references to morphological variation and natural history. Twenty of the species were collected from Kinabalu regions and the others from various localities in the surrounding lowlands. Tadpole of *Megophrys baluensis* and unknown tadpole of *Ansonia* are described; variation in *Rana kuhli* is analysed and striped form is newly reported from Borneo; *Rana rugulosa* is first recorded from Sabah; distribution of *Kaloula pulchra pulchra* is confirmed; *Rana kenepaiensis* is first recorded from eastern Sabah and differentiated as a distinct species from *R. paramacrodon*; two probable new forms of *Amolops* are compared with known Bornean relatives; distribution of *Polypedates leucomystax leucomystax* in eastern Sahah is a significant range extension.

Studies on the amphibian fauna of Borneo Island have a long history since the end of last century. Early workers intensively studied herpetology of Mt. Kinabalu (e.g. SMITH, 1931). More recently, INGER (1966) compiled a monograph from vast amount of systematic and ecological informations on Bornean amphibians on the basis of his experience from several long trips to the island.

As a result of this valuable publication, more is known about the systematics and biogeography of the amphibian fauna of Borneo than of any other part of Southeast Asia. As better understood the amphibian fauna is, additional field work may continue to produce significant informations.

According to INGER's monograph (op. cit.), 89 species of amphibians occur in Borneo, and even recently, additional species is also reported (ISKANDAR, 1978). Some of them are common and widespread, while others are rare, restricted in distribution, and little is known on their natural history. As to amphibians of Kinabalu regions, little observations have been made on their behavior, reproductive habits, and microhabitats, inspite of their long history of faunal survey as mentioned above (INGER, 1978). Consequently, the collection and observation of even a small number of amphibian species in this region can be particularly noteworthy.

Two biological expeditions of Kyoto University have made herpetological collections in Sabah. The first expedition, 1976, operated field bases at the Kinabalu National Park (KNP), Telupid, and limestone caves on the East Coast, for two months

* Contributions from "The 2nd Kyoto University Biological Expedition to Sahah", No. 1.

(KOBAYASHI and HOTTA, 1978). A small collection of amphibians was made by Dr. Tsuneaki KOBAYASHI, a mammalogist, at KNP in August 1976.

The second Kyoto University Biological Expedition to Sabah, organized by Dr. Toshitaka HIDAKA and conducted by Dr. T. KOBAYASHI, Mr. T. HIKIDA, and myself was operated between 10 March and 4 April 1979. Entomological staffs of the Forest Research Center, Sepilok, headed by Prof. Ryôzo YOSII, joined our party and assisted in making herpetological survey at KNP.

We spent twelve days at KNP (locality description is given in KOBAYASHI and HOTTA, 1978) and fourteen days around Kota Kinabalu. In this short trip my intensive efforts were concentrated in studying the habits of frogs and toads in various habitats, making temperature (air (AT), water (WT), and ground (GT)) recordings of respective microhabitats, recording information on appearance in life with photographs in color, tape-recording the mating calls of several species, and collecting specimens for future study. Collecting specimens in KNP area is controlled and most of the specimens were presented by generous native people. The specimens thus collected are now in the collection of Biological Laboratory, Yoshida College, Kyoto University.

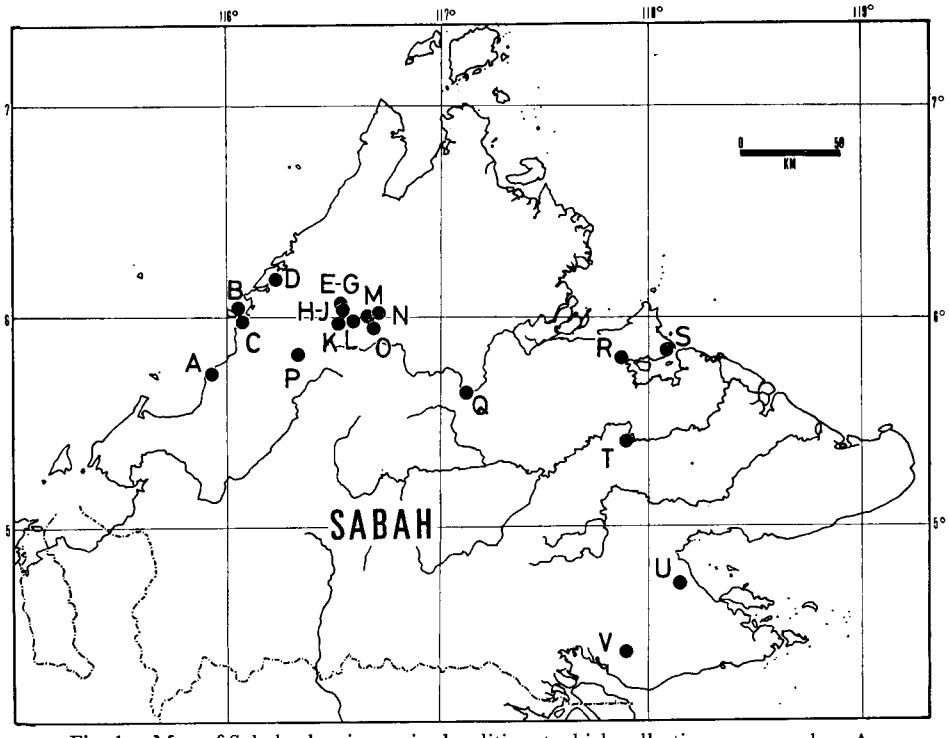

Fig. 1. Map of Sabah, showing major localities at which collections were made. A, Papar; B, Gaya Island; C, Kota Kinabalu; D, Tuaran; E, Panar Lavan; F, Power Station; G, Kambarangoh road; H, KNP Headquarters; I, Liwagu River; J, Silau Silau Stream; K, Bundu Tuhan; L, Kundassan; M, Mamut; N, Poring Hot Spring; O, Ranau; P, Gunong Alab; Q, Telupid; R, Sepilok Forest Reserve; S, Sandakan; T, Batu Puteh; U, Madai Cave; V, Mt. Lucia.

In addition to the collections made by the first and second Kyoto University expeditions, the following three small collections form the basis of this study; (1) collection of the Osaka Museum of Natural History (OMNH), (2) that presented by Prof. R. Yosii and (3) by Mr. T. Hikida. The first collection was made by Dr. Mitsuru Hotta, a botanist, at various parts of Sabah, between October 1968 and February 1969. The second was made spontaneously during 1978–1979 mostly at Sepilok Forest Reserve, Sandakan, by Prof. R. Yosii and entomological members of the Forest Research Center. The third collection was made by Mr. T. Hikida at several localities of Sabah from July to August 1979.

The purpose of this paper is to preliminarily discuss the findings of interest to herpetologists that have resulted from study of the specimens and field observations. Particular attention was paid for morphological variation, though sample size is too small for analyses in many species.

Analyses of stomach contents and mating calls of several species, together with taxonomic conclusions of the specimens whose identifications are at present uncertain, will be reported in future papers.

Specimens of several frogs and toads related to the species treated in the present paper were also examined for comparisons. These are in OMNH and Field Museum of Natural History (FMNH) collections.

Basically three measurements were made for transformed specimens: snout-vent length (SVL)—direct line distance from the tip of the snout to the anterior margin of the vent; head width (HW)—the greatest width of the head; tibia length (Tibia L)—straight length of the tibia. Other measurements were taken on some species: internarial distance—the distance between centers of the external nares; diameter of the tympanum—greatest diameter of the tympanic ring; parotoid length (PL)—greatest length (excluding conjunct warts, if present) of the parotoid gland; parotoid width (PW)—greatest width; diameter of the disk of the third finger—greatest diameter; foot length—distance from the proximal edge of the inner metatarsal tubercle to the tip of the longest (fourth) toe.

For larvae, two measurements were made: total length (Tot L)—straight line distance from the tip of the head to the end point of the tail fin; body length (BL)—direct line distance from the tip of the head to the distal point of body. Tail length (Tail L) is calculated by subtracting BL from Tot L. Tadpoles are assigned to the developmental stages of Gosner (1960).

Ratios were routinely calculated as the standards of body proportions, but no statistical analysis was performed following discussions by Atchley et al. (1976).

Almost all the specimens of transformed frogs and toads, lacking evident secondary sex characters, were sexed by the results of dissection.

Species Accounts

Leptobrachium gracilis **Günther** Fig. 2

Liwagu River, KNP, 1500 m, 1 larva.

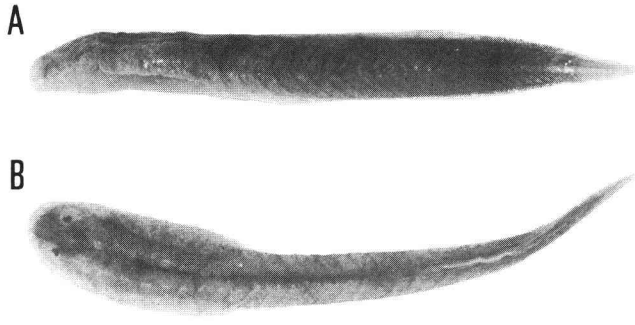

Fig. 2. Lateral (A) and dorsal (B) views of tadpole of *Leptobrachium gracilis*, St. 28, Tot L 61 mm.

BL 21.5 mm; Tot L 61.0 mm; Tail L 1.84 of BL.

A larva in stage 28 was collected in a stream with moderate current and gravel bed. It was difficult to find the tadpole whose pale body color well matched with clear pebbles on the bottom of the stream.

Leptobrachium hasselti **TSCHUDI** Figs. 3–4

KNP Headquarters—Kambarangoh road, KNP, 1665–1750 m, 6 males + 2 females + 1 subadult female + 46 larvae; Silau Silau Stream, KNP, 1620–1665 m, 5 males + 1 female + 1 subadult female + 11 larvae: Liwagu River, KNP, 1500 m, 32 larvae; near Power Station, KNP, 1900 m, 1 male + 6 larvae; Poring Hot Spring, 555 m, 1 larva.

Females collected in August contained small pigment free ova, and those collected in mid March had large ova (2.2 mm). These ova are grayish white in color.

Two males and one subadult female were found by day hopping on the forest floor near stream or on roadside in logged forest (GT 19.5 C). The remaining transformed frogs were caught at night on the bank of streams or attracted to light for feeding. In August, a male was observed calling at night on the edge of a small stream and the calling male clasped a female in captivity (Fig. 3).

Metamorphosing tadpoles (stages 40 and 43), showing the characteristics of adult *L. hasselti*, were collected in a side pool of a modestly flowing stream in mid March. The tadpoles of this species were most abundant around Headquarters region and were frequently found in pools of small streams (WT 14.5–18.5 C) or near the shore of

Table 1. Measurements (in mm) and ratios to SVL of *Leptobrachium hasselti*.

	N	SVL		Head width		Tibia length	
		Range	Mean±SD	Range	Median	Range	Median
♂ Ad.	12	42.2–54.8	50.3±3.2	.418–.469	.444	.351–.391	.368
♀ Ad.	3	62.7–63.8	63.2	.416–.444	.431	.354–.364	.354
♀ Y.	2	45.5–57.2	51.4	.416–.426	.421	.399–.409	.404

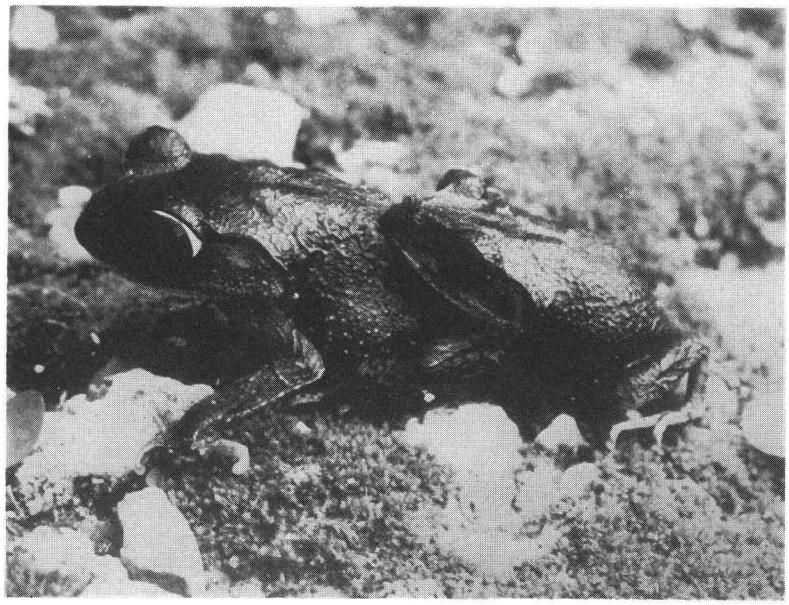

Fig. 3. *Leptobrachium hasselti* clasping at KNP Headquarters.

wide streams. They hid themselves under stones by day and were actively feeding on substrate materials at night. Larvae with no limb buds varied in size (Tables 2–3), and the suitability of application of GOSNER's table for this species in pre-limb bud stages is an open question. I tentatively include all the pre-limb bud stage tadpoles into stage 25. Size variability in a given stage is great even in samples from one pool. Nevertheless, the body size in the present series is larger than in tadpoles from eastern Sabah reported by INGER (1966) (Table 4).

Table 2. Measurements (in mm) of larvae of *Leptobrachium hasselti* from Kinabalu region.

St.	Body length			Total length		
	N	Range	Mean±SD	N	Range	Mean±SD
25	26	6.7–14.2	9.3±1.8	24	14.7–37.2	25.1±5.4
26	18	12.2–19.2	15.4±2.3	17	34.0–58.2	45.6±8.5
27	7	15.8–20.2	17.7±1.7	7	47.3–61.0	52.4±5.9
28	12	16.2–22.3	19.3±2.5	12	46.2–66.2	56.2±7.6
29	8	16.5–21.8	18.7±1.6	8	50.8–63.2	54.9±4.3
31	8	19.8–25.8	21.3±1.9	10	56.0–75.0	61.7±5.1
32	2	20.2–25.2	22.7	2	60.3–71.7	66.0
33	3	18.8–21.0	20.0±1.1	1		61.2
35	3	21.2–22.2	21.9±0.6	3	65.2–67.2	66.2±1.0
36	2	22.7–28.2	25.5	2	69.2–84.5	76.9
37	3	22.2–23.2	22.6±0.5	3	65.2–66.5	65.9±0.7
38	1		23.8	1		72.8

Table 3. Tail ratio to BL of larvae of *Leptobrachium hasselti* from Kinabalu region.

St.	N	Range	Median	St.	N	Range	Median
25	24	1.16-1.85	1.71	33	1		1.91
26	17	1.68-2.64	1.91	35	3	1.98-2.08	2.03
27	7	1.90-2.08	1.93	36	2	2.00-2.05	2.02
28	12	1.72-2.03	1.91	37	3	1.81-2.00	1.93
29	8	1.77-2.08	1.96	38	1		2.06
31	10	1.78-2.09	1.98	42	1		1.75
32	2	1.85-1.99	1.92	43	1		0.99

Table 4. Comparison of body length of larvae of *Leptobrachium hasselti* from Kinabalu with those from eastern Sabah and Sarawak. Data on eastern Sabah and Sarawak specimens from INGER (1966) and larval developmental stages are adapted to GOSNER's (1960) table.

	Stages 26–32			Stages 32–37		
	N	Range	Median	N	Range	Median
Kinabalu	53	12.2-25.8	15.1	13	18.8-28.2	25.8
Eastern Sabah	126	11 -18	14.5	28	16 -21	17.9
Sarawak	8	17 -27	22.6	6	24 -34	28.0

Also, the present series has fewer rows of labial teeth than in tadpoles described by Inger (Table 5). These differences might partly be due to differences in micro-habitats from where samples were taken.

Table 5. Frequency distribution with respect to number of divided labial tooth rows in larval *Leptobrachium hasselti* from Kinabalu region.

St.	Upper lip						Lower lip						
	3-3	3-4	4-4	4-5	5-5	6-6	3-3	3-4	4-4	4-5	5-5	5-6	6-6
25	2	1	14		9		1		16		8		
26			2		17				2		17		
27			2		5						7		
28			3	1	7	1				1	10	1	
29			3		3					1	5		
31			3		6	1			1		8		
32				1	1						1		1
33					1						1		
35			2		1						3		
36			1			1					2		
37			3								3		
38			1								1		

?Leptobrachium nigrops **BERRY and HENDRICKSON** Fig. 4

Kenipir River, near Ranau, ca. 500 m, 1 larva.

BL 19.8 mm; Tot L 55.0 mm; Tail L 1.78 of BL. Labial teeth I:5–5/6–6:I.

The identification of the larva is uncertain, resting on its resemblance in coloration with the description of presumable larva of *L. nigrops* (INGER, 1966).

The larva in stage 36 was found under a submerged stone in a moderately flowing stream. The dark markings on back clearly seen in this tadpole were never found in large series of larval *L. hasselti* specimens (Fig. 4).

INGER's assignation of tadpoles of *Leptobrachium* with light body and broad dark

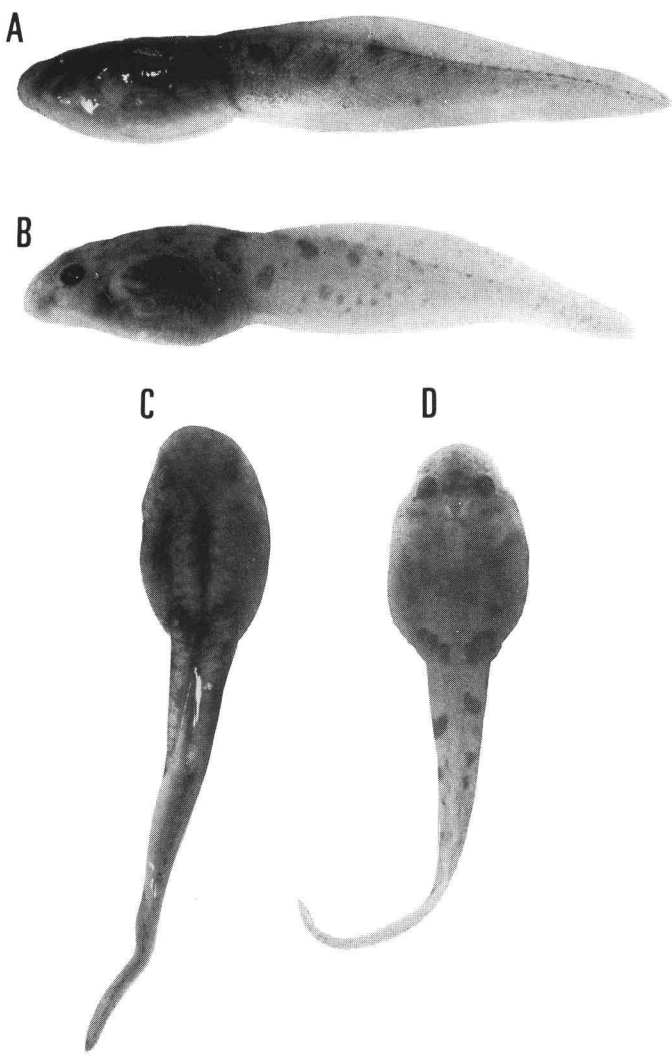

Fig. 4. Lateral (A, B) and dorsal (C, D) views of tadpoles of *Leptobrachium hasselti*, St. 35, TL 66.2 mm (A, C), and *?L. nigrops*, St. 36, Tot L 55 mm (B, D).

markings on the root of the tail to *L. nigrops* has been questioned (BERRY, 1972), and further investigations are required to ascertain the taxonomic status of this larval *Leptobrachium*.

Megophrys monticola nasuta (SCHLEGEL) Fig. 5

KNP Headquarters, ca. 1650 m, 1 female.

SVL 110.0 mm; HW 0.484 of SVL; Tibia L 0.435 of SVL.

The female had small white ovaries, apparently showing postbreeding conditions. In this female the rostral appendage is almost absent while the triangular projections from upper eyelids are moderately developed (width of eyelid, including projection, is 0.16 of SVL). The length of calcified skin on dorsum equals 0.56 of SVL. In these characteristics, in addition to its large body size, the female represents an intergrading population of *m. monticola* and *m. nasuta*.

The most remarkable characteristics of this specimen is the condition of skin folds on dorsum (Fig. 5): one pair of longitudinal folds in this specimen are short and about half length of SVL—the distinct traits of *M. m. ligayae* from Palawan. The mixed condition of subspecific diagnostic characters found in this specimen supports INGER's taxonomic treatments on this species complex (INGER, 1954, 1966).

Megophrys baluensis (BOULENGER) Fig. 6

Kambarangoh road KNP, 1800 m, 2 males + 3 larvae.

The two adult males measure: SVL 43.0 and 45.2 mm; HW 0.435 and 0.443 of SVL; Tibia L 0.428 and 0.414 of SVL, respectively.

These males, collected in mid March, had well developed nuptial pad consisted of black clusters of fine spinules covering the dorsal and medial surfaces of the first finger

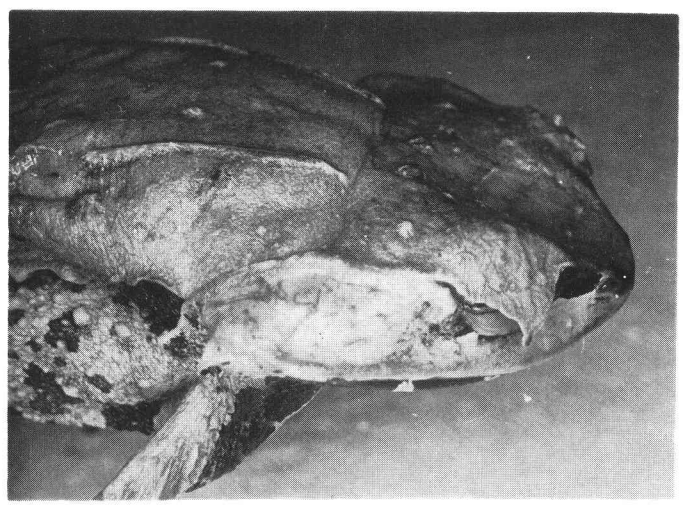

Fig. 5. Profile of female *Megophrys monticola nasuta* from KNP Headquarters, showing absence of rostral appendage and short dorsal skin folds.

and the dorsal surface of the second finger (cf. INGER, 1966: 48). They were found by day under piles of wet stones below a small waterfall, which is forming a small stream crossing a road in logged forest.

Three Megophryne tadpoles having funnel mouths (Fig. 6) were collected from a quiet portion of the small stream (WT 17.5 C) only two meters apart from the place where adults of *M. baluensis* were caught. Consequently, the most likely parent of the tadpoles is *M. baluensis*.

Two tadpoles in stage 26 (with short limb buds) have BL 8.2 and 8.8 mm and Tot L 24.5 and 27.8 mm, respectively. The remaining tadpole is in stage 28 and has BL

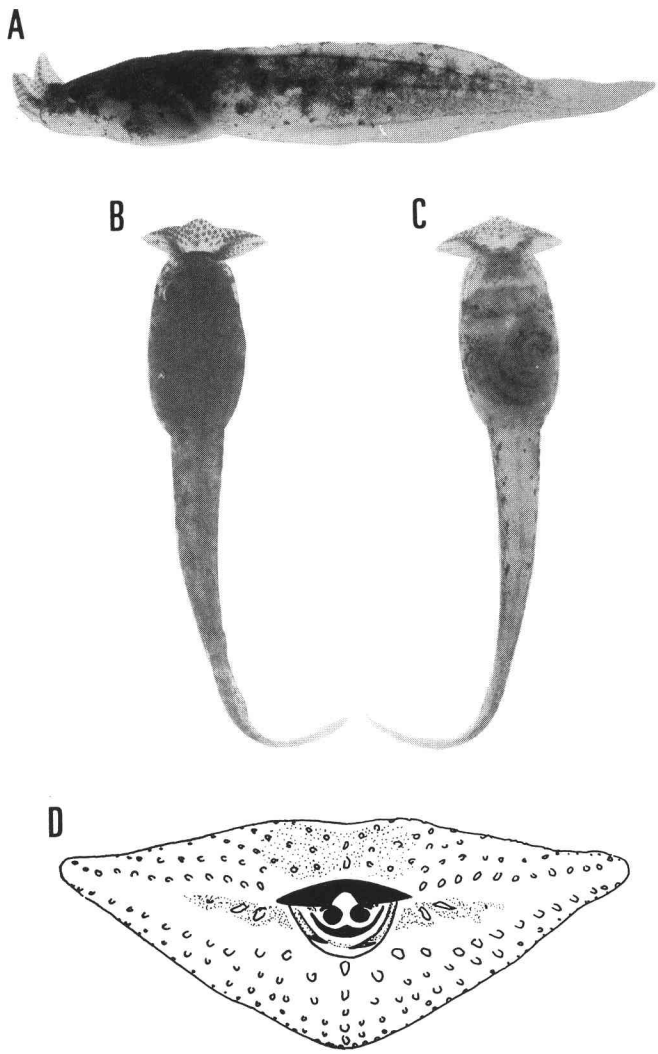

Fig. 6. Tadpole of *Megophrys baluensis*, St. 26, Tot L 27.8 mm. A, lateral view; B, dorsal view; C, ventral view; D, mouth (×10).

of 10.2 mm and Tot L of 27.2 mm.

Although three larvae resemble larval *M. monticola nasuta* described by INGER (1966), they have slightly smaller body size; INGER gave BL values of larval *M. monticola* in pre-limb bud stage (up to stage 25 of GOSNER) 8.9–11.6 mm (mean 9.9).

The present tadpoles agree structurally with larval *M. monticola* described in VAN KAMPEN (1923) and INGER (op. cit.), except in coloration. Comparisons with the available *M. m. ligayae* tadpoles from Palawan (OMNH unnumbered) gave the similar results: venter of *ligayae* is more lightly colored than back, yet guts are almost hidden under colored skin and thick abdominal muscles. By contrast, venter of the tadpoles in question is more or less transparent, with scattered pigments, and intestines are discernible externally (Fig. 6-C).

BOULENGER (1912) also indicated the dark belly of *Megalophrys montana* (=*Megophrys monticola*). Since the tadpoles of the genus *Megophrys* are structurally very similar with each other (see keys in POPE, 1931 and LIU and HU, 1961), notable differences in the ventral coloration between tadpoles in question and larval *M. monticola* is considered to strengthen the assignation of the former to *M. baluensis*.

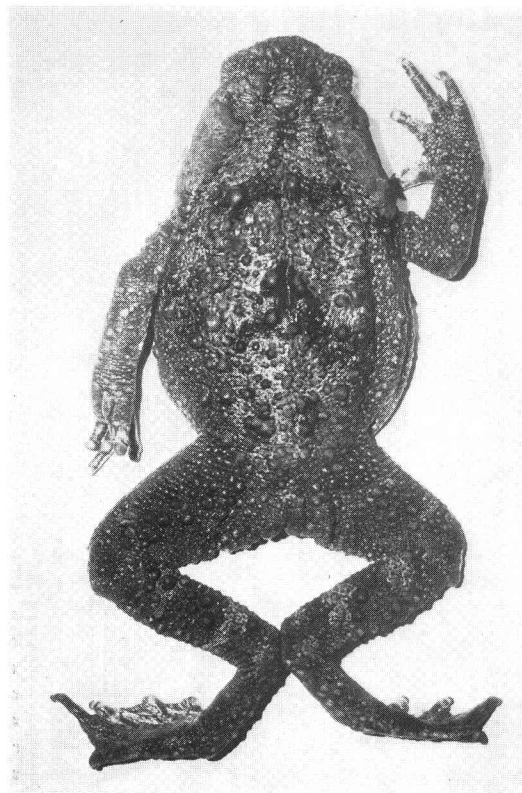

Fig. 7. Dorsal view of *Bufo juxtasper* from Ranau, female, SVL 180 mm.

Bufo bipocratus divergens PETERS

Sepilok Forest Reserve, 0–50 m, 1 female.

SVL 46.2 mm; HW 0.329 of SVL; Tibia L 0.416 of SVL; PL 0.178 of SVL; PW 0.50 of PL.

The female obtained in December had enlarged dark pigmented ova.

Bufo juxtasper INGER Fig. 7

Ranau, 504 m, 28 juveniles + 5 males + 5 females; 2 km SSW Mamut, 1300 m, 1 female; Mt. Lucia, Tawau, 250 m, 1 juvenile.

The presence of a single vocal slit is one of the diagnostic characters which differentiate *juxtasper* from *asper* (INGER, 1964, 1966). In my series, however, two out of five males with well developed nuptial pads have paired slit-like openings.

The other characteristics such as long parotoids of these two are quite similar with the remaining specimens. Hence, the number of vocal slits is not a valid criterion in differentiating *juxtasper* from *asper*.

Females collected in March and August had convoluted oviducts but ova were small and unpigmented.

One juvenile was caught by day among stones in a ditch on grass field near human habitation. All the remaining juveniles and most of the adults were found hopping at rainy night in the same field. One of the large females is found by day on the forest floor of lower limit of oak forest.

In mid March, callings were heard on the bank of a wide river and some males collected emitted mating and release calls and tried to clasp female individuals in captivity. Although neither larvae nor egg masses were found in the river, it is highly probable that this species is a stream-breeder like the closely related *B. asper* (VAN KAMPEN, 1923; BERRY, 1972).

This species is very active and jumps long distance and, when captured, it soon secrets poison and smells badly.

Table 6. Measurements (in mm) and ratios of *Bufo juxtasper*.

	N	SVL		HW/SVL	
		Range	Mean±SD	Range	Median
Juv.	28	45.2- 92.2	61.3±11.0	.354-.394	.369
♂ Ad.	5	95.2-114.0	106.4± 8.7	.357-.367	.364
♀ Ad.	6	107.0-180.0	141.3±31.4	.345-.371	.359

	Tibia/SVL		Parotoid L/SVL		Parotoid W/PL	
	Range	Median	Range	Median	Range	Median
Juv.	.465-.527	.487	.166-.244	.194	.348-.490	.407
♂ Ad.	.452-.489	.472	.188-.231	.200	.339-.428	.384
♀ Ad.	.400-.475	.463	.196-.247	.219	.327-.467	.406

Ansonia fuliginea (MOCQUARD)

near Panar Lavan, KNP, 3000–3480 m, 2 females (1 specimen OMNH unnumbered).

The two females measure: SVL 40.8 and 43.5 mm; HW 0.317 and 0.346 of SVL; Tibia L 0.377 and 0.391 of SVL, respectively.

The female caught in August had large unpigmented ova.

Ansonia hanitschi INGER Figs. 8–11

Silau Silau Stream, KNP, 1620–1650 m, 9 males + 7 females + 2 immature males + 3 immature females.

The specimens agree with the description of *A. hanitschi* in most respects (INGER, 1960, 1966), except the presence of a weak but distinct tarsal ridge in most individuals (Fig. 9). The condition of the tarsal ridge in them is like some specimens in the type series of *A. minuta* (FMNH 77423 and 77427), but not so developed as in other *A. minuta* specimens (FMNH 77421, 77422–25) and *A. albomaculata* type series (FMNH 81975, 81977, 96026–29).

Toe webbing in adult mlaes (modally only one phalanx free of web on the third and fifth toes) is found more pronounced than INGER's statements (two phalanges free) (Fig. 10). INGER (1966) considered sex dimorphism in this character only slight, but as shown in Figure 10 and in Table 8, adult males have more developed webbing than females and juveniles.

Adult male has vocal sac and nuptial pad, both are lacking in two juveniles. Most of the females collected in mid March had large unpigmented ova (1.8–2.5 mm). Immature females had small white ovaries.

Compared with *A. minuta* and *A. albomaculata*, the present specimens have longer feet. Although the relative foot length to SVL is not markedly large, foot length related to tibia is larger in this species than in *A. minuta* and *A. albomaculata* (Table 9).

Most of the specimens were collected by day on gravel banks of shaded streams of modest currents (WT 17.5 C) in dark forest. They were found sitting or walking slowly among stones (AT 20 C). One was found at night on leaves of a shrub one meter above the ground. No calling was heard in mid March.

Table 7. Measurements (in mm) and ratios to SVL of *Ansonia hanitschi*.

	N	SVL		Head width		Tibia length	
		Range	Mean±SD	Range	Median	Range	Median
♂ Y.	2	24.8–26.9	25.9	.274–.286	.280	.528–.572	.550
♀ Y.	3	24.3–27.4	25.4±1.7	.266–.286	.267	.547–.555	.547
♂ Ad.	9	26.1–29.2	27.3±0.9	.258–.272	.264	.473–.510	.498
♀ Ad.	7	29.2–32.4	31.5±1.1	.243–.268	.256	.469–.507	.477

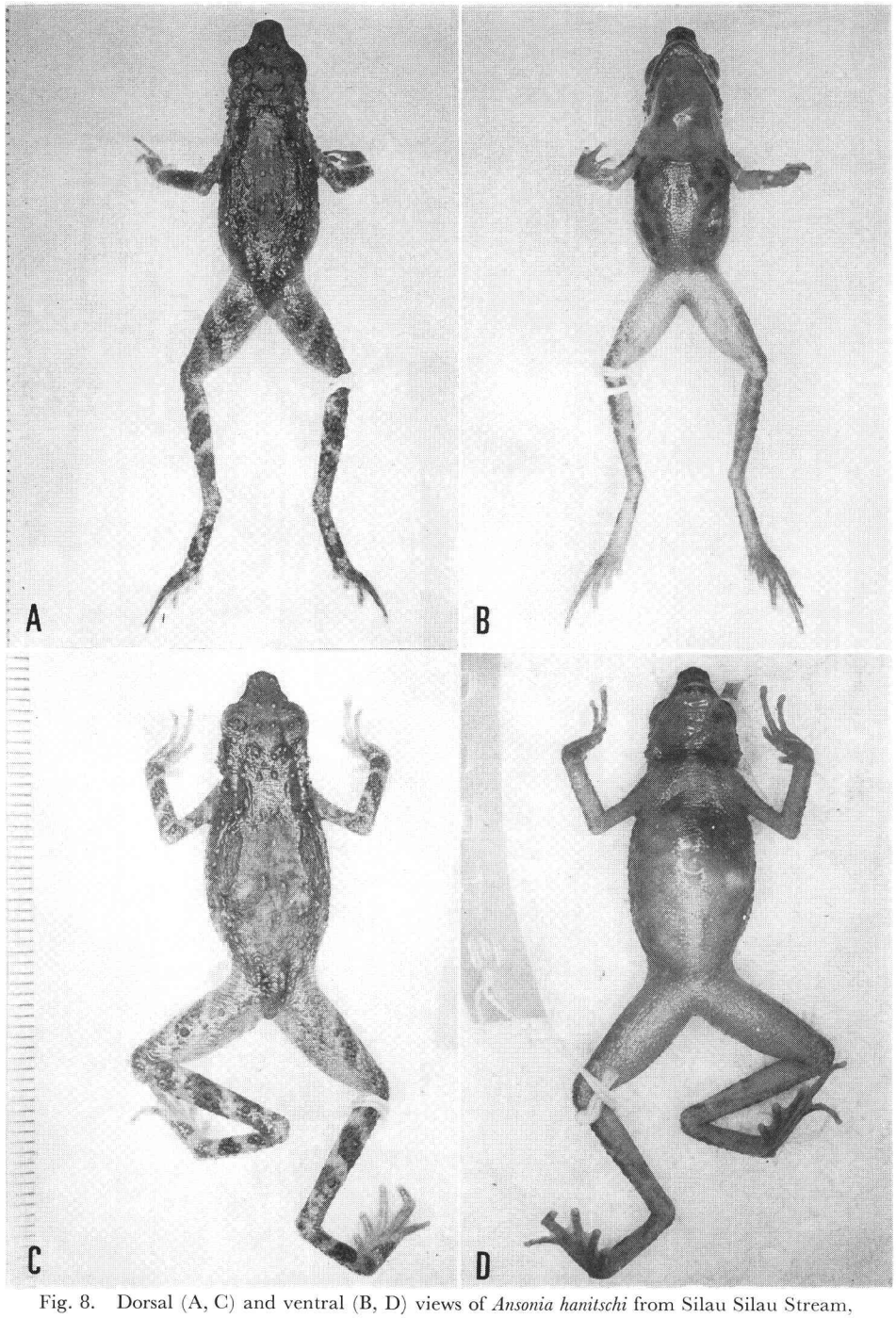

Fig. 8. Dorsal (A, C) and ventral (B, D) views of *Ansonia hanitschi* from Silau Silau Stream, KNP. A, B, male, SVL 27.2 mm; C, D, female, SVL 31.7 mm.

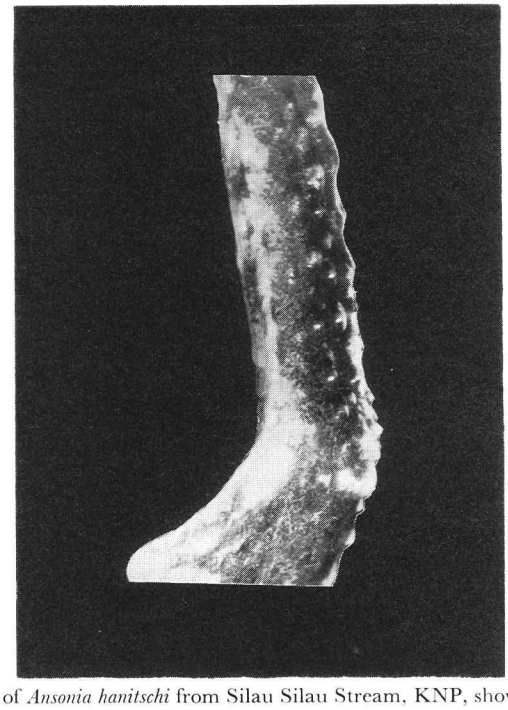

Fig. 9. Tarsus of *Ansonia hanitschi* from Silau Silau Stream, KNP, showing tarsal ridge.

***Ansonia* sp.** Figs. 12–13

Mamut River, Mamut, 1260 m, 2 larvae.

The two tadpoles in stages 31 and 41 measure: BL 9.3 and 11.2 mm; Tot L 24.2 and 29.8 mm; Tail L 1.60 and 1.66 of BL, respectively. The labial teeth are II/III in both specimens.

No adult *Ansonia* were collected in the immediate vicinity and pertinent identification must wait until more information is accumulated.

These tadpoles resemble probable larval *A. minuta* (INGER, 1960) in having the halves of the anterior beak apart from each other and in having inframarginal papillae

Table 8. Variation in extent of web in *Ansonia hanitschi*.
Figures indicate number of specimens.

	Free of phalanges										
	3rd toe			4th toe			5th toe				
	1	1 1/2	2	3	3 1/2	4	1	1 1/2	2	2 1/2	3
♂ Y.			2	1		1			1	1	
♀ Y.		1	2			3			3		
♂ Ad.	5	2	2	8	1		4	3	1		1
♀ Ad.		1	6	1	3	3			4	2	1

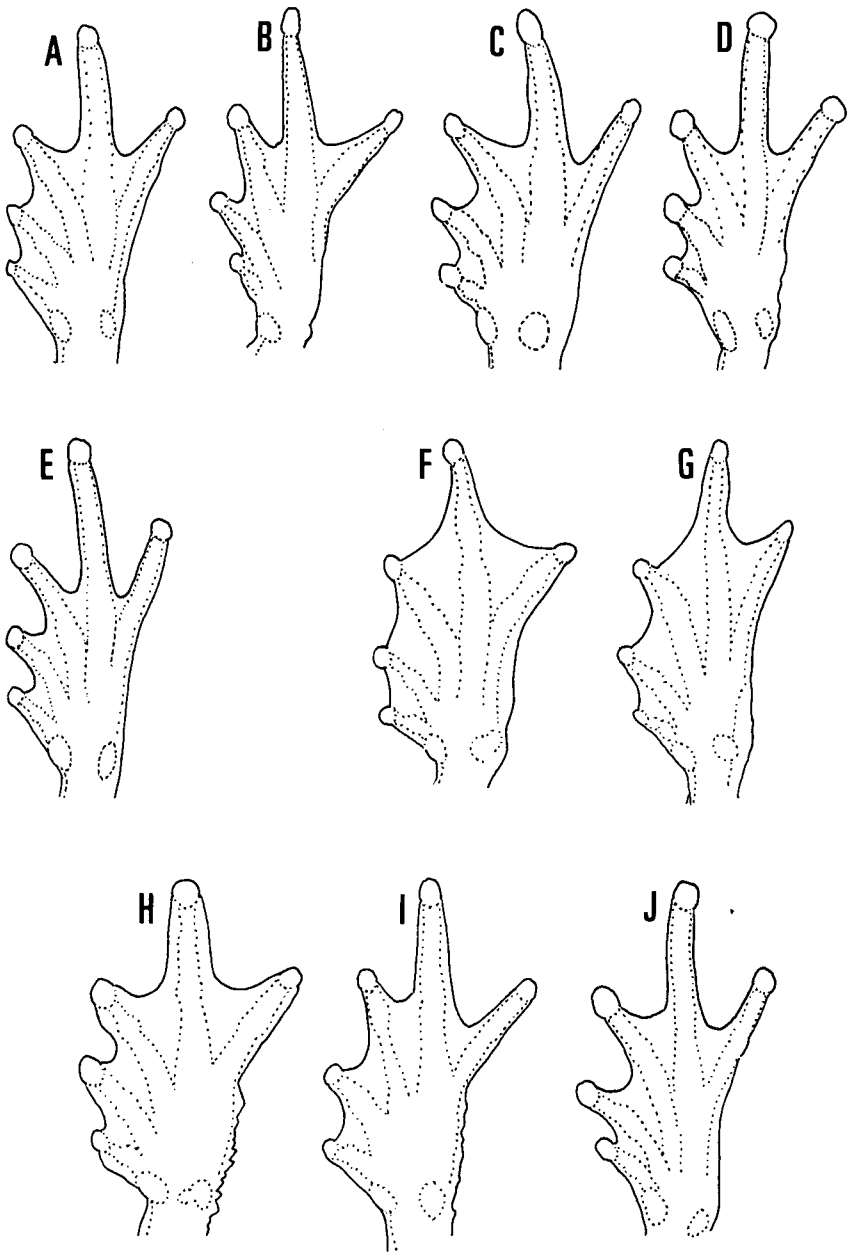

Fig. 10. Planter views of three Bornean *Ansonia* species. A–E, *A. hanitschi* from Silau Silau Stream, KNP (A-C, male; D–E, female); F, G, *A. albomaculata* from Sarawak (F, FMNH 81975, male; G, FMNH 96026, male); H–J, *A. minuta* from Sarawak (H, FMNH 77424, male; I, FMNH 77421; J, FMNH 77427). Magnifications: A, ×3.7; B, ×3.7; C, ×4.3; D, ×3.2; E, ×3.1; F, ×5.2; G, ×4.6; H, ×4.5; I, ×4.3; J, ×3.9.

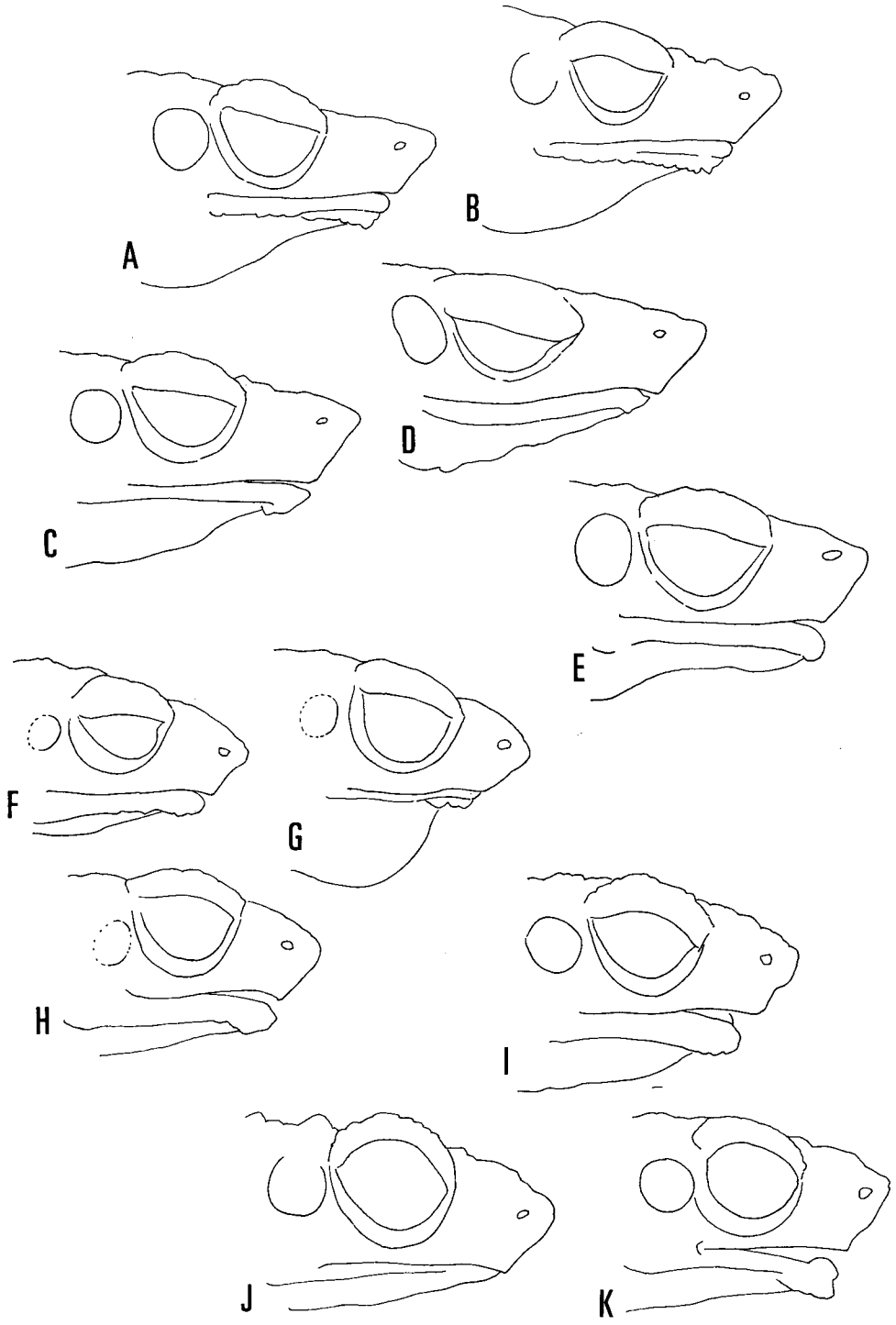
A
B
C
D
E
F
G
H
I
J
K

Table 9. Comparison of relative foot length among three Bornean *Ansonia* species.

		N	Foot/SVL		Tibia/Foot	
			Range	Median	Range	Median
A. minuta	♂ Ad.	1		.404		1.35
	Y.+♀Ad.	4	.399–.456	.431	1.31–1.37	1.34
A. albomaculata	♂ Ad.	6	.373–.413	.396	1.39–1.47	1.41
A. hanitschi	♂ Y.	2	.452–.476	.464	1.17–1.20	1.19
	♀ Y.	3	.440–.445	.441	1.13–1.26	1.24
	♂ Ad.	9	.395–.436	.414	1.13–1.29	1.18
	♀ Ad.	7	.403–.426	.413	1.11–1.20	1.16

on posterior lip (Fig. 13). But the anterior beak halves are more widely separated in the present tadpoles than in *A. minuta*. They have irregular, but assuredly more than two series of numerous large and small inframarginal papillae on larger length of posterior lip. Inframarginal papillae in *A. minuta* constitute two scattered rows. Whether or not these differences are related to larval development is unclear, but somewhat distant locations from where *A. minuta* and the present tadpoles were obtained seem to suggest that they are closely related but not identical.

The older tadpole has well developed hindlimb with light bars dorsally (Fig. 12, B, D). Toe webbing is developed and about one phalanx is free of web on the third and fifth toes. The presence of tarsal ridge is also suggested. Of the seven species of *Ansonia* hitherto recorded from Kinabalu regions (INGER, 1978), only *A. albomaculata* has been considered to have tarsal ridge. In addition, *A. hanitschi* is proved to have ridge as discussed above. Tadpole of *A. albomaculata*, however, lacks inframarginal papillae on lower lip (INGER, 1960), different from the larvae in question. The known lower limit of vertical distribution of *A. hanitschi* (1275 m) is almost same height with the location where the tadpoles in question were collected (1260 m).

However, the highest degree of speciation is occurring in the genus *Ansonia* around Kinabalu regions and it may be more reasonable to consider the present tadpoles as distinct species closely related to Sarawak *A. minuta* than assigning to *A. hanitschi*.

The larvae were collected in mid March under submerged stones in a clear stream having strong currents.

***Kaloula pulchra pulchra* GRAY** Fig. 14

Kota Kinabalu, 10 m, 5 males; KNP Headquarters, 1665 m, 1 female.

The five males were found at night hopping on grassland in the towns of Kota Kinabalu. The single female from Mt. Kinabalu was found at night feeding on insects

Fig. 11. Lateral views of head of three Bornean *Ansonia* species. A–E, *A. hanitschi* from Silau Silau Stream, KNP (A–C, male; D, E, female); F–H, *A. albomaculata*, male (F, FMNH 81975; G, FMNH 96028; H, FMNH 96026); I–K, *A. minuta* (I, FMNH 77424, male; J, FMNH 77421; K, FMNH 77427). ×5.

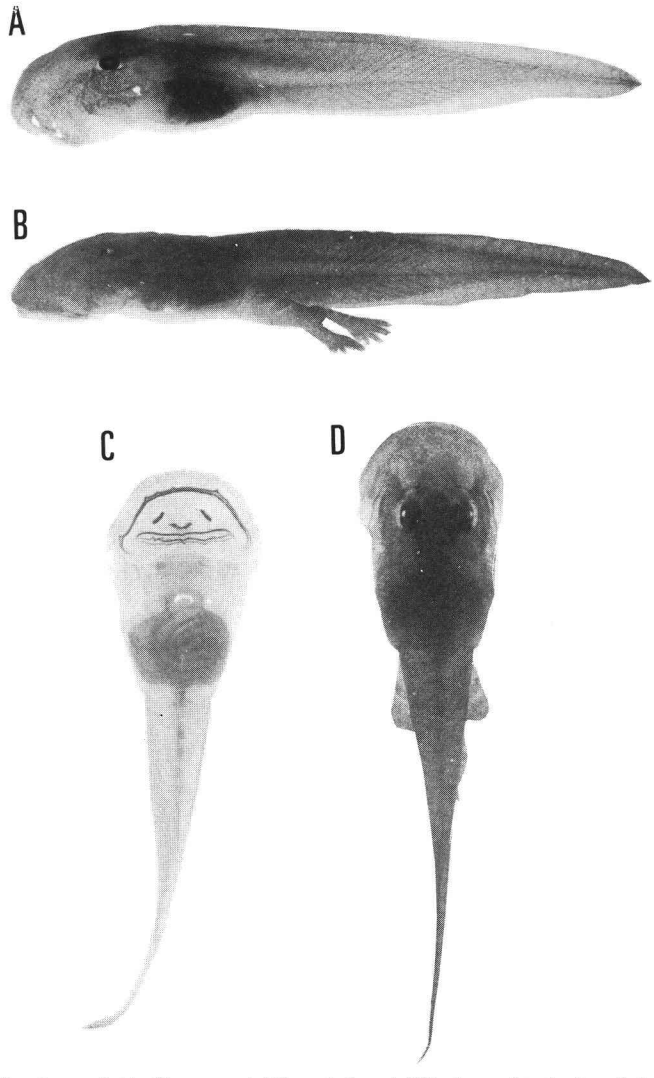

Fig. 12. Lateral (A, B), ventral (C) and dorsal (D) views of tadpoles of *Ansonia* sp. from Mamut River, Mamut. A, C, St. 31, Tot L 24.4 mm; B, D, St. 41, Tot L 29.8 mm.

attracted to lights.

Only one authentic record has hitherto been reported from Borneo (INGER, 1966) and the present series might belong to recently introduced populations.

***?Kalophrynus pleurostigma pleurostigma* TSCHUDI** Figs. 15–16

Silau Silau Stream, KNP, 1620 m, 1 male + 1 immature female.

The male and the immature female measure: SVL 34.8 and 28.3 mm; HW 0.313 and 0.332 of SVL; Tibia L 0.417 and 0.396 of SVL, respectively.

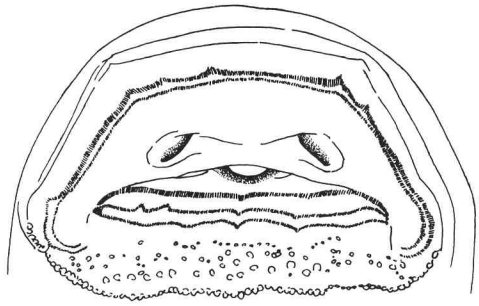

Fig. 13. Mouth of *Ansonia* sp. from Mamut River, Mamut. ×9.6.

The male has two slit-like vocal sac openings in the floor of the mouth, but it lacks nuptial pad. The young female has poorly developed ovaries.

The presence of nuptial pad in the adult males is stressed in Philippinese *pleurostigma* and reemphasized in Bornean population (INGER, 1954, 1966). The absence of nuptial pad in the present male is possibly due to later development of this organ than that of vocal slits, but the specimens have some other discrepancies to be assigned the name of *pleurostigma*. Fourth finger is shorter than in *pleurostigma* (Fig. 16A).

The two specimens completely lack inguinal occeli (Fig. 15A). Absence of occeli is found only in 7% of the Philippinese *pleurostigma* examined by INGER (1954), and TAYLOR (1962) described the specimen lacking occeli from Thailand. No Bornean specimen has been reported to lack occelli (INGER, 1966: 134). In addition, SVL of

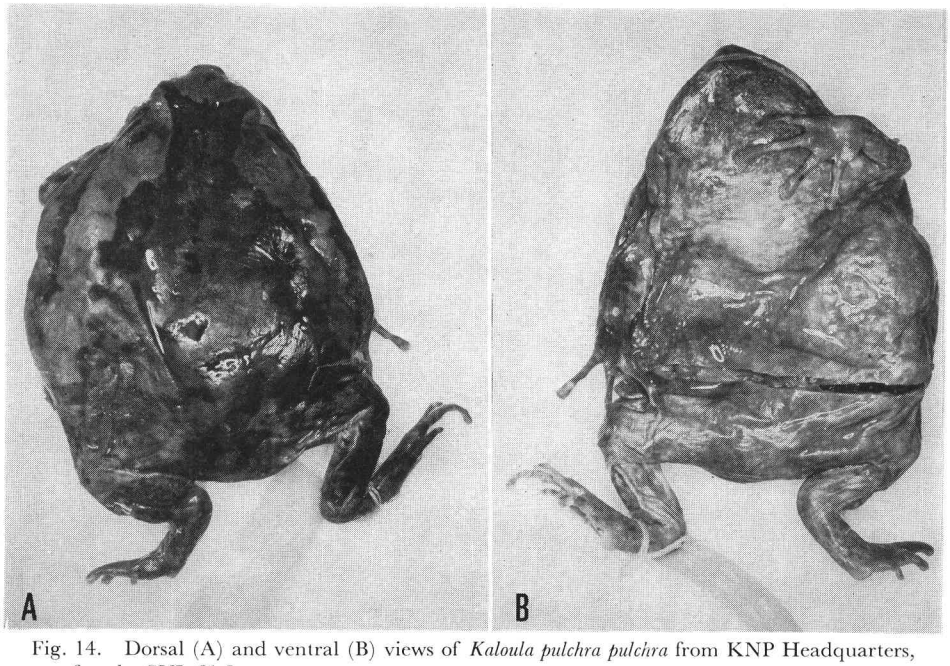

Fig. 14. Dorsal (A) and ventral (B) views of *Kaloula pulchra pulchra* from KNP Headquarters, female, SVL 61.5 mm.

Table 10. Measurements (in mm) and ratios to SVL of *Kaloula pulchra*.

	N	SVL		Head width		Tibia length	
		Range	Mean±SD	Range	Median	Range	Median
♂ Ad.	5	37.8–54.2	47.5±6.3	.354–.393	.382	.293–.347	.344
♀ Ad.	1		61.5		.364		.317

the present male (34.8 mm) is slightly out of the range of the species (37.0–50.4 mm) given in INGER (1966). Two Cambodgean *pleurostigma* examined (OMNH-AM-2527-28) had large occeli and stouter habitus and lacking small dark blotches under thigh and tibia, which are evident in our specimens (Fig. 15, B).

Otherwise the present specimens have the common traits with *K. pleurostigma* and are tentatively identified as that species.

The specimens were collected on the forest floor near a stream (GT 20 C). The male was found by day resting under a log and the juvenile was found walking at night.

***Chaperina fusca* MOCQUARD**

Liodan River, Bundu Tuhan, 990 m, 1 female.

SVL 22.4 mm; HW 0.317 of SVL; Tibia L 0.500 of SVL.

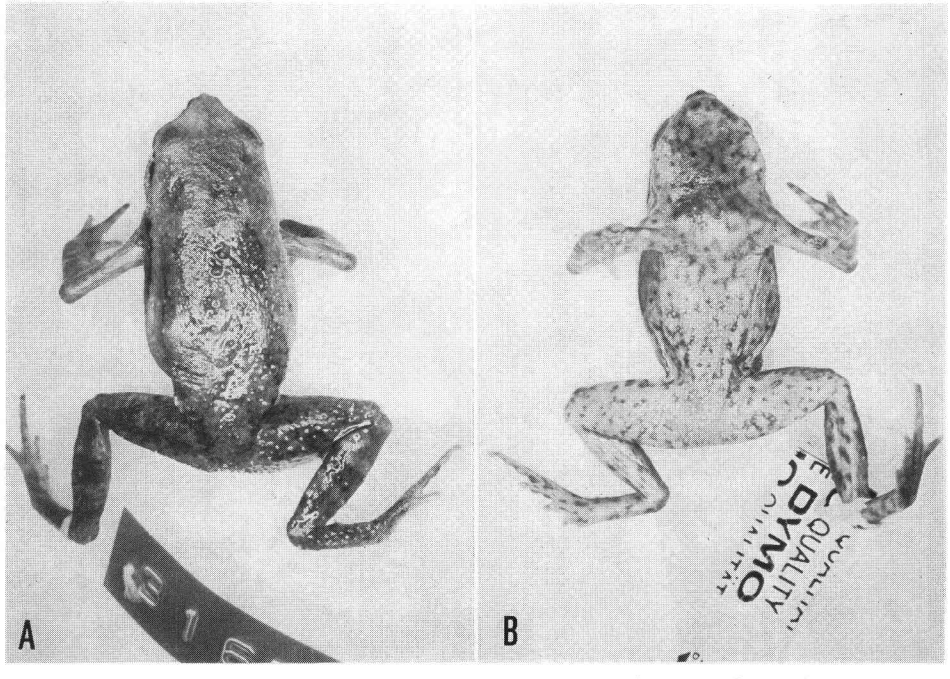

Fig. 15. Dorsal (A) and ventral (B) views of ?*Kalophrynus pleurostigma* from Silau Silau Stream, KNP, male, SVL 34.8 mm.

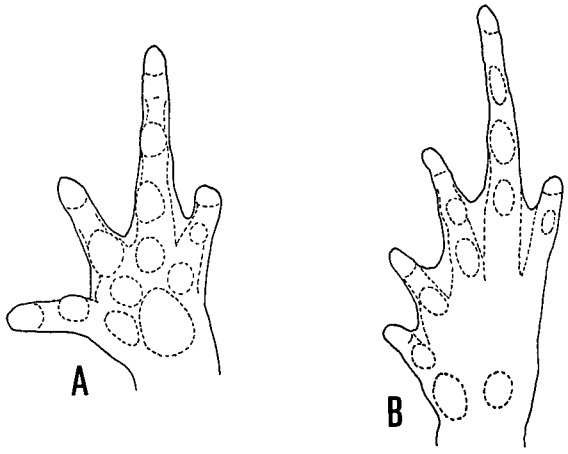

Fig. 16. Palmar view of hand (A, ×4.6) and planter view of foot (B, ×3.9) of *?Kalophrynus pleurostigma*, male.

The female with enlarged darkly pigmented ova and no dorsal spots, was collected by day under a stone (GT 24.5 C) on the bank of a stream in mid March.

***Microhyla borneensis* PARKER**

Poring Hot Spring, 555 m, 1 female; Sepilok Forest Reserve, 50–100 m, 1 immature female.

The adult and immature females measure: SVL 22.2 and 18.2 mm; HW 0.324 and 0.352 of SVL, Tibia L 0.631 and 0.758 of SVL, respectively.

The adult female collected in late March had enlarged dark pigmented ova and was found hopping by day on the forest floor.

***Rana blythi* BOULENGER**

Murok, midway betw. Ranau and Telupid, ca. 500 m, 1 subadult male; Sepilok Forest Reserve, lower than 50 m, 1 immature female + 1 subadult male; Madai Cave, below 50 m, 2 females.

The two females measure: SVL 85.0 and 96.8 mm; HW 0.348 and 0.355 of SVL; Tibia L 0.598 and 0.570 of SVL, respectively. Two immature males with poorly developed mandibular projections and moderate sized heads measure: 60.2 and 78.2 mm; HW 0.385 and 0.373 of SVL; Tibia L 0.611 and 0.524 of SVL, respectively.

One male was found by day perching on rocky bank of a stream with *Amolops jerboa* and jumped into the stream when frightened. Two females were collected at night on gravel stream bank. Females collected in mid August had large yellowish ova, 2.2 mm in diameter.

***Rana cancrivora cancrivora* GRAVENHORST**

Kota Kinabalu, 10 m, 2 metamorphosed juveniles; Gaya Island, 5 m, 2 males + 2 subadult males; Papar, below 50 m, 1 male + 4 females + 4 subadult females +

Table 11. Measurements (in mm) and ratios to SVL of *Rana cancrivora*.

	N	SVL		Head width		Tibia length	
		Range	Mean±SD	Range	Median	Range	Median
Meta. Y.	2	16.8–19.1	18.0	.356–.369	.363	.482–.488	.485
♂ Y.	2	41.0–46.0	43.5	.371–.374	.372	.507–.517	.512
♀ Y.	6	29.5–48.6	40.6±8.5	.346–.379	.368	.451–.498	.479
♂ Ad.	3	47.0–56.5	52.8	.350–.354	.353	.494–.513	.496
♀ Ad.	4	56.0–65.2	61.8±4.4	.337–.365	.359	.472–.484	.480

2 juveniles; Sepilok Forest Reserve, below 10 m, 8 larvae.

Of the females collected during late March to early April, specimens larger than 55 mm SVL had darkly pigmented ova, 1 mm in diameter, and those 35–55 mm had a few small pigmented ova. Males larger than 47 mm had vocal slits and nuptial pad, but ventral asperities (INGER, 1954, 1966) could not be detected, partly because of poor conditions in preservation. The minimum SVL values of adults here treated are almost similar to those given in INGER (1966).

At Gaya Island, several *cancrivora* were found with *R. erythraea* near sea shore. They were found by day in the bank hole of an artificial small pond. *R. erythraea* was found in water, but most of *cancrivora* hid themselves in holes on the bank facing the water. When disturbed, they jumped into the water but soon they climb again on the bank and remained in the holes.

Several metamorphosing young were found in ditches in the towns of Kota Kinabalu in mid March.

A series of tadpoles ranging from no limb bud to undifferentiated toes was collected from the manglove swamp in late July. These larvae well fitted the description of larval *R. cancrivora* by INGER (1966), having teeth row I:I–I/III.

Rana chalconota raniceps (PETERS)

Meliau River, Telupid, ca. 100 m, 1 male (OMNH unnumbered); Sandakan, lower than 50 m, 1 metamorphosed juvenile.

The male and metamorphosed juvenile measure: SVL 38.4 and 14.0 mm; HW 0.297 and 0.307 of SVL; Tibia L 0.583 and 0.550 of SVL, respectively.

The metamorphosed juvenile with a trace of tail was collected in early August

Table 12. Measurements (in mm) and ratios to Body L of larvae of *Rana cancrivora*.

St.	N	Body length		Total length		Tail ratio	
		Range	Mean±SD	Range	Mean±SD	Range	Median
25	5	3.8–4.2	4.0±0.2	8.2–8.7	8.5±0.2	1.05–1.29	1.16
31	1		9.7		24.2		1.50
32	1		9.8		25.2		1.57
33	1		10.0		24.9		1.49

Table 13. Measurements (in mm) and ratios to SVL of *Rana erythraea*.

	N	SVL		Head width		Tibia length	
		Range	Mean±SD	Range	Median	Range	Median
Y.	9	17.2–27.0	24.0±3.0	.294–.336	.329	.467–.512	.489
♂ Y.	17	26.2–38.2	30.4±3.2	.304–.337	.317	.466–.529	.497
♀ Y.	25	24.8–46.2	36.7±5.8	.301–.348	.323	.460–.569	.525
♂ Ad.	15	33.2–39.8	35.8±2.4	.291–.356	.325	.470–.580	.503
♀ Ad.	27	46.8–66.8	53.1±5.3	.293–.337	.315	.443–.572	.500

on a bank of a drainage ditch.

I could not detect the presence of nuptial pad and humeral gland in the male collected in late December.

Rana erythraea (SCHLEGEL)

Kota Kinabalu, 10 m, 2 males + 11 females + 1 subadult female + 9 immature males + 9 immature females + 6 juveniles; Gaya Island, 5 m, 2 immature males; Papar, lower than 50 m, 8 males + 13 females + 1 subadult female + 3 immature males + 10 immature females + 1 juvenile; Ranau, 504 m, 6 males + 6 females + 2 immature males + 5 immature females + 1 juvenile; Batu Puteh, Kinabatangan, lower than 50 m, 1 female + 1 immature female.

The smallest mature size was determined as 33 mm in male and 47 mm in female in the present collection. These values are almost identical with those reported for Sarawak population (INGER and GREENBERG, 1963).

Females collected from mid March to early April contained ova developing in various degree, and some had pigmented ova, 1.3 mm in diameter. At Ranau, males were found calling at night along the edges of ditches and paddy fields (WT 26.5 C) in mid March.

This species is most abundant around human habitations and was frequently found at night in temporary pools in the city of Kota Kinabalu. In Ranau, *erythraea* was hardly found by day in the places where calling aggregation was observed at night. Some individuals were found by day resting under logs on the coast of Papar.

Dorsal coloration is changeable in an individual frog from strong green to pinkish brown.

Rana kuhli **DUMÉRIL and BIBRON** Figs. 17–18

KNP Headquarters—Kambarangoh road, KNP, 1665–1750 m, 3 males + 3 females + 7 immature males + 12 immature females + 10 metamorphosed juveniles + 10 larvae; Silau Silau Stream, KNP, 1620–1665 m, 5 females + 9 immature males + 17 immature females; near Power Station, KNP, 1750–1900 m, 1 male + 8 immature males + 8 immature females + 2 metamorphosed juveniles + 9 larvae; Kundassan, 1365 m, 1 immature male + 1 female (OMNH unnumbered); Bundu Tuhan, 1280 m, 2 males + 1 female + 10 immature males + 10 immature females

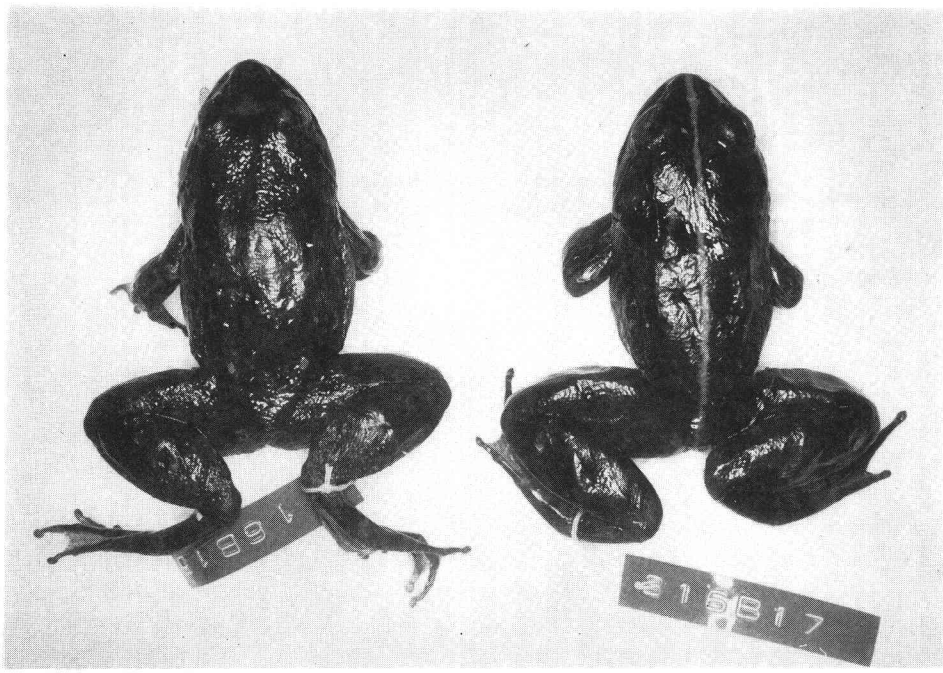

Fig. 17. Dorsal views of females of *Rana kuhli* from Silau Silau Stream, KNP, showing the absence (left) and presence (right) of light vertebral stripe. ×0.75.

+ 36 metamorphosed juveniles + 10 larvae; Poring Hot Spring, 555 m, 1 male + 1 female; Gunong Alab, 1740 m, 3 immature males + 1 immature female; Sepilok Forest Reserve, 50–100 m, 1 female + 1 metamorphosing young + 1 larva.

INGER (1966) observed *kuhli* from eastern Sabah had more numerous warts than

Table 14. Measurements (in mm) and ratios to SVL of *Rana kuhli*.

	N	SVL		Head width	
		Range	Mean±SD	Range	Median
♂ Y.	34	20.9–46.4	33.4± 7.1	.393–.458	.427
♀ Y.	37	20.5–54.8	32.5± 8.2	.386–.462	.418
♂ Ad.	7	44.2–83.2	58.1±13.8	.444–.501	.462
♀ Ad.	12	50.8–69.2	62.7± 7.3	.376–.422	.408

	Tibia length		Internarial width	
	Range	Median	Range	Median
♂ Y.	.454–.532	.508	.091–.126	.106
♀ Y.	.466–.550	.504	.089–.119	.107
♂ Ad.	.483–.537	.506	.086–.100	.090
♀ Ad.	.431–.530	.509	.082–.097	.088

Table 15. Frequency distribution in the condition of tibial warts in *Rana kuhli* from Northern Borneo.
'+' and '—' indicate presence and absence of tibial warts, respectively.

	♂ Ad.		♀ Ad.		♂ Y.		♀ Y.		Meta. Y.		Tot.	
	+	—	+	—	+	—	+	—	+	—	+	—
Kinabalu	0	4	0	77	0	29	0	40	0	3	0	83
Poring	1	0	1	0							2	0
Gunong Alab					0	3	0	1			0	4
Sandakan			0	1							0	1

Sarawak specimens. In my sample, mostly from Kinabalu region, only a pair from Poring had tibia with numerous large and small warts and all the remaining had at most only very weak warts on the distal fourth of tibia (Table 15). Thus western Sabah frogs more resemble to Sarawak samples in this character. Moreover, one female from Sandakan had smooth tibia contrasting to INGER's observation.

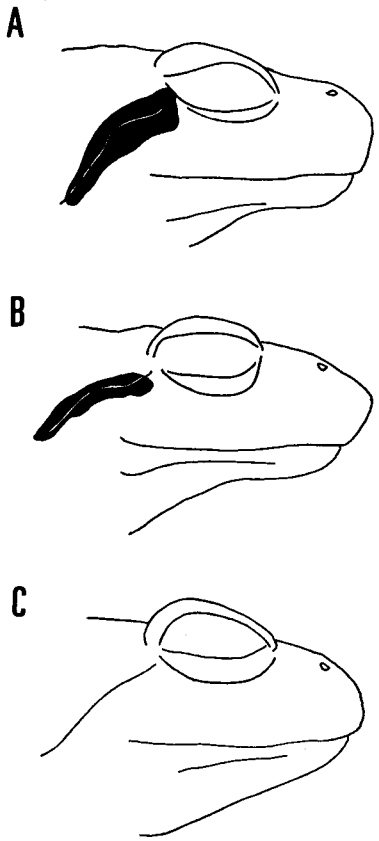

Fig. 18. Lateral views of head of *Rana kuhli*, showing the temporal stripe variations. A, wide; B, narrow; C, no stripe.

Table 16. Frequency and width of temporal stripe in *Rana kuhli* from Northern Borneo. 'W' and 'T' indicate wide and thin stripes, respectively and 'A' indicates absence of stripe.

	♂ Ad.			♀ Ad.			♂ Y.			♀ Y.			Meta. Y.			Tot.		
	W	T	A	W	T	A	W	T	A	W	T	A	W	T	A	W	T	A
Kinabalu	3	1	0	2	4	1	13	16	0	13	27	0	1	2	0	32	50	1
Poring	0	1	0	0	1	0										0	2	0
Gunong Alab							3	0	0	1	0	0				4	0	0
Sandakan				1	0	0										1	0	0

The condition of black oblique stripe along tympanic region was examined on the basis of INGER's criteria (Fig. 18). The result is summerized in Table 16. Of the eight specimens from western Sabah examined by INGER, six (75%) had wide and two (25%) had narrow stripes. In our sample from Kinabalu regions, however, 32 (38%) and 52 (61%) of 85 frogs had wide and narrow stripes, respectively. The number of samples examined by Inger is too small for precise comparisons, but our sample seems to more resemble with specimens from eastern Sabah in this character.

INGER (op. cit.) observed *kuhli* from Sabah lacked confluent dorsal spots. In our sample, however, 17 out of 83 frogs (20%) had such spots (Table 17). Again in this character our sample resembles to Sandakan frogs, but the observed difference might have been partly biassed by subjective grading different from INGER.

The presence of blackish stripe on the anterior face of the upper arm was also examined (Table 18). Of the 83 specimens from Kinabalu region, 20 (24%) had such stripe. This is almost the same freqeuncy observed in eastern Sabah sample by INGER.

Following the analyses by INGER (op. cit.), relative size of the space between the nostrils is examined (Table 14). The calculated ratios and those given by INGER do not overlap in ranges: my sample includes individuals with even wider internarial space than in Sarawak population, which is reported to have nostrils more widely separated than in Sabahan *kuhli* (INGER, 1966). The reason for this contradiction is unclear,

Table 17. Frequency and condition of dorsal spot in *Rana kuhli* from Northern Borneo. "H' and 'L' indicate heavy and light dorsal pigmentation, respectively and 'A' indicates absence of dorsal dark spots.

	♂ Ad.			♀ Ad.			♂ Y.			♀ Y.			Meta. Y.			Tot.		
	H	L	A	H	L	A	H	L	A	H	L	A	H	L	A	H	L	A
Kinabalu	1	2	1	2	3	2	6	13	9	7	17	15	1	0	2	17	35	29
Poring		01	0	0	0	1										0	1	1
Gunong Alab							0	2	1	0	1	0				0	3	1
Sandakan				0	0	1										0	0	1

Table 18. Frequency distribution in the condition of dark stripe on upper arm in *Rana kuhli* from Northern Borneo. '+' and '—' indicate presence and absence of dark mark, respectively.

	♂ Ad.		♀ Ad.		♂ Y.		♀ Y.		Meta. Y.		Tot.	
	+	—	+	—	+	—	+	—	+	—	+	—
Kinabalu	1	3	2	5	6	21	10	30	1	2	20	61
Poring	0	1	0	1							0	2
Gunong Alab					0	3	0	1			0	4
Sandakan			0	1							0	1

but again, the way of measurements may have been different.

TAYLOR (1962) found a few of *kuhli* from Thailand possessed a white mid-dorsal stripe. INGER (1966) mentioned nothing for this character in discussing variation in Bornean population. I could find 17 (10.9%) out of 156 *kuhli*, mostly from western Sabah, had light stripe mid-dorsally (Fig. 17). Frogs with dorsal stripe were found more frequently among young individuals (Table 19). Although the sample size is too small for discussion in adults is evident, the tendency that the stripe is more frequently found among smaller juveniles than among larger ones suggests higher mortality in striped juveniles.

Table 19 also suggests the clinal increasement of striped individuals with altitude: striped frogs are more frequently found in higher elevations. There were no tangible differences in the habitats of frogs with and without stripe, and both forms were found simultaneously in an aggregation of metamorphosing froglets.

Compared with other ranid species (e.g. *R. limnocharis*: MORIWAKI ,1953; INGER, 1954; KURAMOTO, 1968), scarcely any investigation has so far been made on the frequency of light stripe in *R. kuhli*. Future studies in the geographic variation in this character must be based on detailed regional surveys.

For the size at sexual maturity in Bornean *kuhli*, INGER (1966) gave the values of 43.9 mm for males and 50.7 mm for females. In our sample, some males around 45 mm in SVL had nuptial pads on the first finger, but others lacked them. Therefore, sexual maturity is reached at slightly larger size in our sample than in samples presented by Inger.

Table 19. Frequency of mid-dorsal light stripe in *Rana kuhli* from Kinabalu region.

Loc.	Alt. (m)	♂A.	♀A.	♂Y.	♀Y.	Meta. Y.	Tot.	(%)
Power Station	1750-1900	0/1	—	2/8	2/8	0/2	4/19	(21. 1)
HQ-Kambarangoh	1665-1750	1/3	0/3	0/7	3/12	3/10	7/35	(20. 0)
Silau Silau	1620-1665	—	2/5	0/9	3/17	—	5/31	(16. 1)
Bundu Tuhan	1280	0/2	0/1	0/10	0/10	1/36	1/59	(1. 7)
Poring	555	0/1	0/1	—	—	—	0/2	(0)

Table 20. Relative growth formulas for regressions of head width-snout-vent length in *Rana kuhli*.

	N	Regression equation	r
		log y=a log x+log B	
Meta. Y.	44	log y=1.019 log x−0.394	0.975
♂ Y.	37	log y=1.041 log x−0.431	0.989
♀ Y.	48	log y=0.978 log x−0.342	0.987
♂ Ad.	7	log y=1.162 log x−0.614	0.998
♀ Ad.	11	log y=1.001 log x−0.390	0.991

Like previous authors (BOULENGER, 1920; LIU, 1936; TAYLOR, 1962), I could not find vocal sac in males. The absence of vocal sac in *R. kuhli* is contrasted with closely related Japanese *namiyei*. The latter species has a pair of openings in the floor of the mouth, the sitatuion first pointed out by INGER (1947) and ascertained by myself. This insures the two as different species.

The smallest female with enlarged ova measured 50.8 mm, almost the same size with that given by Inger. The enlargement of the head in males is the result of changes in growth rates which occurs with sexual maturity (Tables 20, 21).

Females collected from Headquarters in March and August had large ova with pigmented hemisphere. The active breeding season is supposed to last long.

Morphology of tadpoles in our sample well agrees with the previous description of the species (INGER, 1966).

Around Headquarters, two distinct size groups of tadpoles and metamorphosing youngs were seen in mid March. These larvae were found in ditches along roads in logged forest or in the places where small streams form small pools (WT 16.5 C). They hid themselves by day under submerged stones. In the shaded pools, *kuhli* tadpoles were seen with larvae of *Leptobrachium hasselti*. Metamorphosing frogs were seen hopping by day in ditches or near small streams. Transformed larger frogs were found

Table 21. F-values showing the differences between samples of relative growth measurements in *Rana kuhli*. Differences in slope on upper right and differences in position on lower left. Single and double asterisks signify $p<0.05$ and $p<0.01$, respectively.

	Meta. Y.	♂ Y.	♀ Y.	♂ Ad.	♀ Ad.
Meta Y.		F_{77}^{1} 0.235	F_{88}^{1} 0.903	——	——
♂ Y.	F_{78}^{1} 1.011		F_{81}^{1} 2.955	F_{40}^{1} 3.400	——
♀ Y.	F_{89}^{1} 0.024	F_{82}^{1} 2.704		——	F_{55}^{1} 0.059
♂ Ad.	——	F_{41}^{1} 9.338**	——		F_{14}^{1} 7.511*
♀ Ad.	——	——	F_{56}^{1} 0.834	F_{15}^{1} 167.558**	

Table 22. Measurements (in mm) and ratios of larvae of *Rana kuhli* from Kinabalu region.

St.	N	Body length		N	Total length		N	Tail L/BL	
		Range	Mean±SD		Range	Mean±SD		Range	Median
25	2	6.4- 7.2	6.8	1		20.2	1		1.81
29	1		9.2	1		23.4	1		1.54
31	2	9.8-10.4	10.1	2	29.2-30.2	29.7	2	1.81-2.08	1.95
34	1		10.3						
35	2	10.0-10.5	10.3	2	28.0-30.0	29.0	2	1.80-1.86	1.83
36	1		11.8	1		33.8	1		1.86
38	4	11.8-12.8	12.3±0.6	4	33.2-37.8	35.7±2.5	4	1.81-1.95	1.90
40	3	12.5-12.8	12.7±0.2	3	35.3-39.8	37.1±2.4	3	1.76-2.18	1.85
41	10	10.8-13.8	12.3±1.0	9	31.5-42.2	37.8±3.9	9	1.90-2.18	2.06
42	1		12.8	1		37.8	1		1.95
43	1		13.0	1		36.8	1		1.83

under stones and logs immediate vicinity of water (WT 17.5 C) and some were found at night hopping on mossy banks.

An old larva and a metamorphosing frog collected from Sepilok in August were in stages 41 and 46 and had much smaller body sizes (BL 8.3 mm and SVL 9.1 mm, respectively) than Kinabalu sample (Table 22).

Rana kenepaiensis INGER Figs. 19-20

Sepilok Forest Reserve, lower than 50 m, 1 male; Tanegan besar, Kinabatangan, lower than 100 m, 1 female (OMNH unnumbered).

The male and the female measure: SVL 32.4 and 38.0 mm; HW 0.364 and 0.374 of SVL; Tibia L 0.531 and 0.574 of SVL, respectively.

The male collected in December has vocal sac openings on each side of the mouth. The third and fifth toes are broadly webbed to disk, but the fourth webbed broadly to distal subarticular tubercle. The throat is heavily pigmented with brown, contrasting to INGER's original description (INGER, 1966: 233). Nuptial pad is absent.

The female collected in late November contained enlarged (1.3 mm) ova with densely pigmented hemisphere. It had less developed toe webbing than in the male described above: the third and fifth toes narrowly webbed to the first phalanx and the fourth webbed broadly to the third phalanx. The condition is not consistent with INGER's description (op. cit.). The identification of the female is solely based on dark tympanum mask. The throat is white mottled with brown.

The back is rather smooth with feeble lateral ridges in the male, coarsely shagreened with more numerous ridges dorsally in the female.

The presence of vocal slits in the male and symaptric distribution with *R. paramacrodon paramacrodon* in Sepilok (record of *R. p. paramacrodon* in INGER, 1966: 232) suggest *R. p. kenepaiensis* to warrant specific recognition as in the case of *Polypedates leucomystax* and *P. macrotis*.

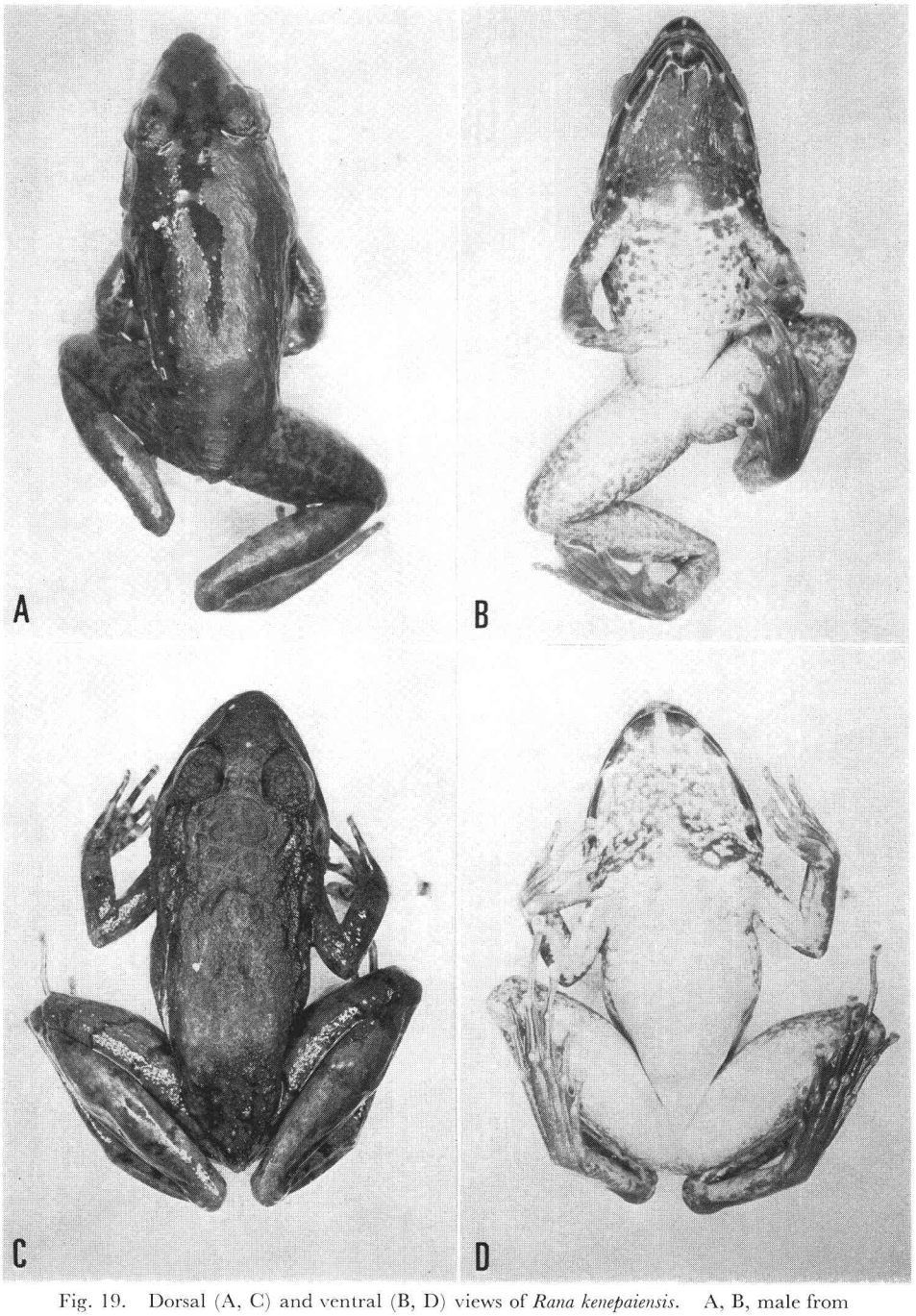

Fig. 19. Dorsal (A, C) and ventral (B, D) views of *Rana kenepaiensis*. A, B, male from Sepilok Forest Reserve, SVL 32.4 mm; C, D, female (identification tentative) (OMNH unnumbered) from Kinabatangan, SVL 38 mm.

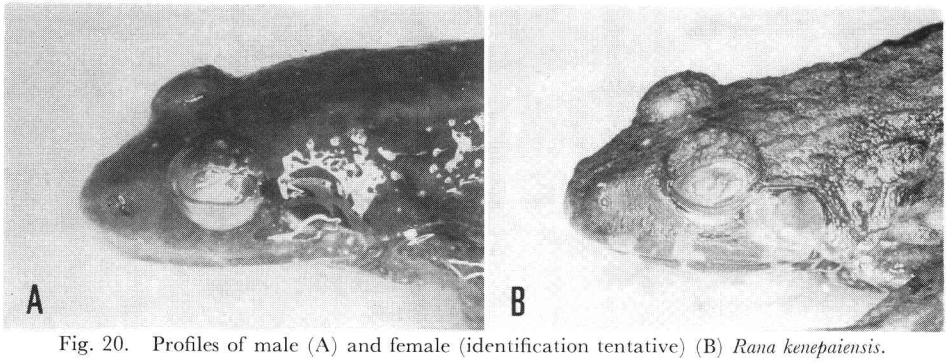

Fig. 20. Profiles of male (A) and female (identification tentative) (B) *Rana kenepaiensis*.

Rana luctuosa (PETERS)

Bundu Tuhan, 1280 m, 2 males + 16 larvae.

The two males measure: SVL 54.7 and 55.2 mm; HW 0.309 and 0.361 of SVL; Tibia L 0.547 and 0.552 of SVL, respectively.

The two males had humeral glands, but lacked vocal sacs and nuptial pads, as stated by INGER (1966).

All the tadpoles except one had dental formula I: 4–4/1–1 :III. The exceptional one had upper lip with divided uppermost labial teeth row. Advanced tadpoles (stage 41) had brown limbs with light bars as in the adults.

Rana microdisca palavanensis (BOULENGER) Fig. 21

Bundu Tuhan, 1280 m, 3 juveniles.

The three specimens, immediately after metamorphosis, measure: SVL 12.2–15.0 mm (mean 13.7); HW 0.377–0.407 of SVL; Tibia L 0.580–0.623 of SVL.

The three specimens collected in mid March are too small for pertinent identification. The presence of disks on toe tips, poor development of webbing, and absence of outer metatarsal tubercle, are characteristics on the basis of which identifications were made.

Table 23. Measurements (in mm) and ratios of larvae of *Rana luctuosa*.

St.	N	Body length		N	Total length		N	Tail L/BL	
		Range	Mean±SD		Range	Mean±SD		Range	Median
31	1		19.2	1		46.8	1		1.44
32	1		20.8	1		52.5	1		1.52
34	1		22.2	1		56.0	1		1.52
35	1		21.2						
36	1		21.8	1		51.2	1		1.35
38	3	23.8–24.8	24.3±0.5	3	61.0–61.8	61.4±0.4	2	1.52–1.60	1.56
39	1		25.3	1		67.2	1		1.66
40	5	23.8–26.3	25.3±1.1	2	62.2–66.5	64.3	2	1.59–1.61	1.60
41	2	25.2–26.3	25.2	2	66.2–71.2	68.7	2	1.63–1.71	1.67

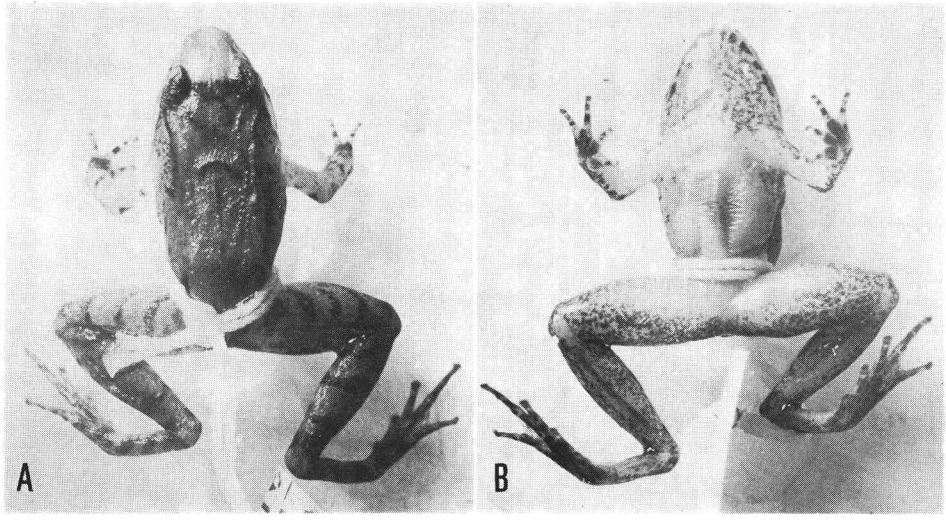

Fig. 21. Dorsal (A) and ventral (B) views of *Rana microdisca palavanensis* from Bundu Tuhan, juvenile, SVL 15 mm.

These specimens, however, differ from *R. microdisca* described by INGER (1966) in the presence of ridge along median edge of the first toe, and in the number of phalanges free of web on the fourth toe being three.

Two of three specimens have dark pigmentation on throat region and anterior and posterior surfaces of thigh. The remaining one has dark back and small white spots on dark upper lip. It has indistinct tympanum and slenderer and more numerous dark bars on hindlimb than in other two specimens, suggesting its different taxonomic status from the latter.

Rana nicobariensis STOLICZKA

Penampang, lower than 50 m, 1 male.

SVL 37.8 mm; HW 0.296 of SVL; Tibia L 0.537 of SVL.

The male, with vocal sac openings and humeral glands, was collected at a rainy night near temporary pools on grassland of human habitation. At the same time two immature *R. rugulosa* were observed.

Rana paramacrodon INGER

Madai Cave, lower than 50 m, 1 immature female.

SVL 41.3 mm; HW 0.383 of SVL; Tibia L 0.562 of SVL.

The specimen was collected in mid August and had small ovaries with small unpigmented ova. It was found at night on the bank of a stream together with *R. blythi*.

Rana rugulosa WIEGMANN Figs. 22–23

Tuaran, lower than 50 m, 58 males + 31 females + 4 subadult females; Penampang, lower than 50 m, 2 immature females.

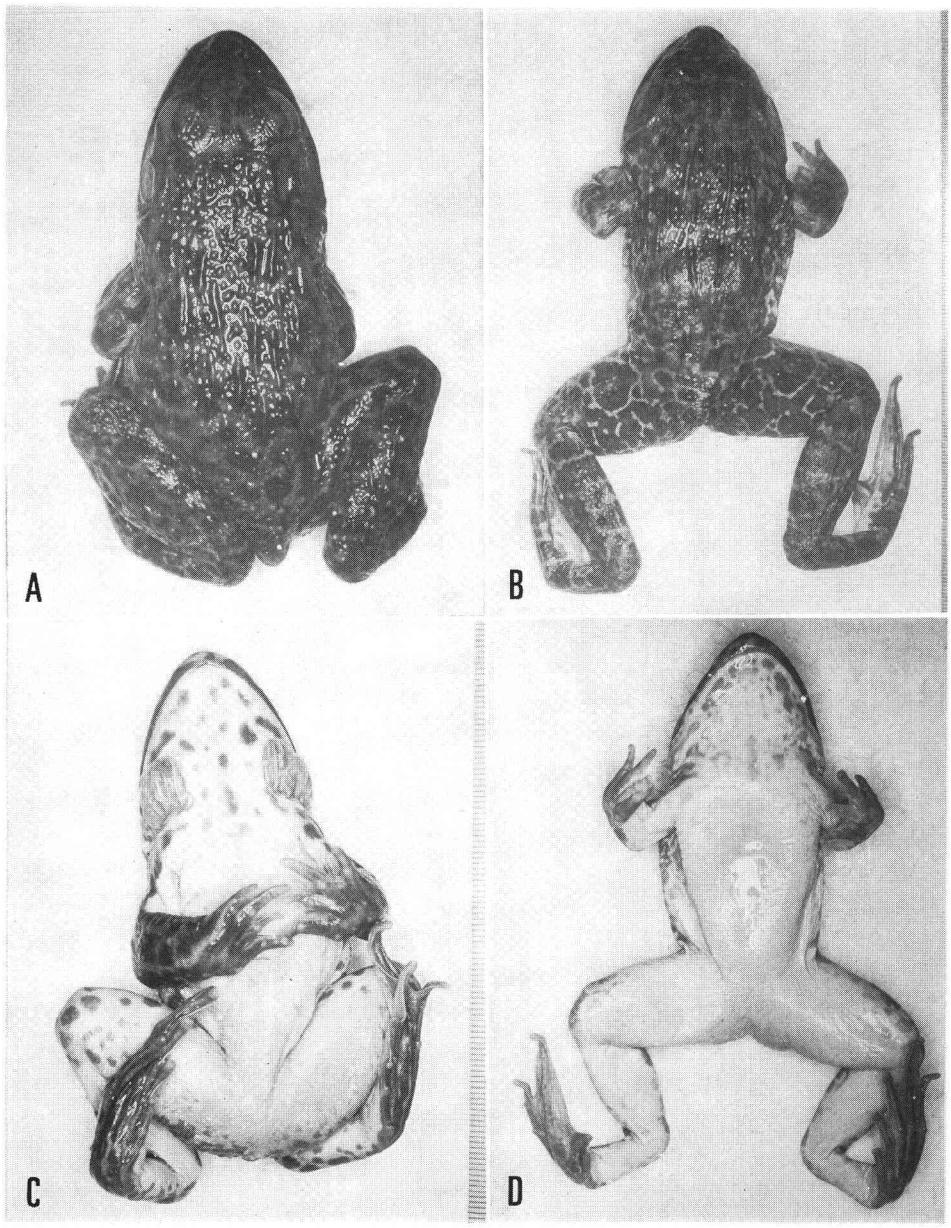

Fig. 22. Dorsal (A, B) and ventral (C, D) views of *Rana rugulosa* from Tuaran. A, C, male, SVL 85.5 mm; B, D, female, SVL 103.2 mm.

This species, not listed in INGER's monograph (1966), is said to be recently introduced from Taiwan for food purpose.

Taxonomic relations of the *Rana tigerina* complex, including the present form, have long been discussed (BOULENGER, 1920; POPE, 1931; TAYLOR, 1962; DUBOIS, 1974),

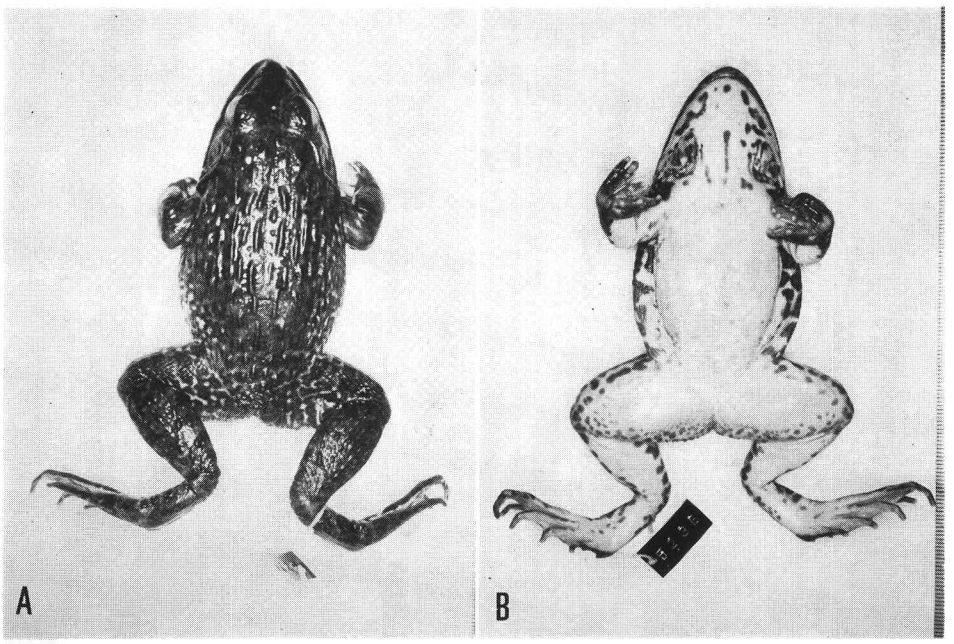

Fig. 23. Dorsal (A) and ventral (B) views of male *Rana rugulosa* from Taiwan, SVL 87 mm.

but no sufficient conclusions are yet reached. The Bornean specimens examined had the characteristics of *rugulosa* or *tigerina pantherina*, having only slight differences from Formosan specimens in relative tibia length (Table 24). I use the name of *rugulosa* rather than *pantherina*, since no significant difference is found between the two in the descriptions of Thailand population (TAYLOR, 1962).

All the Tuaran frogs had been sold alive in the city market for food. They were said to have been collected in the paddy fields nearby. Two juveniles, 43.5 and 47.8 mm in SVL, were collected in August on grassland near human habitation.

Most of the females obtained in late March contained enlarged pigmented ova.

Ooeidozyga baluensis (BOULENGER)

Bundu Tuhan, 1280 m, 1 female + 1 immature female.

Table 24. Comparisons of body size and proportions of *Rana rugulosa* from Tuaran and Taiwan.

	N	SVL		Head width		Tibia length	
		Range	Mean±SD	Range	Median	Range	Median
Tuaran							
♂ Ad.	58	66.2–98.2	84.0±6.0	.327–.379	.352	.415–.483	.449
♀ Ad.	31	77.0–103.2	90.6±6.4	.342–.401	.365	.430–.486	.456
Taiwan							
♂ Ad.	4	64.2–87.0	77.0±9.7	.347–.359	.354	.414–.427	.422

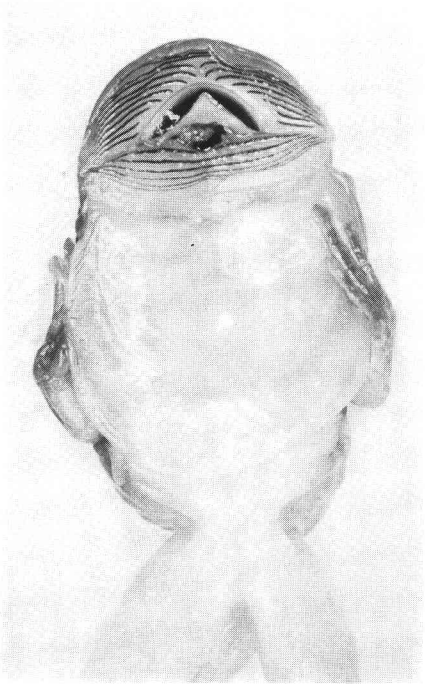

Fig. 24. Ventral view of tadpole of *Amolops cavitympanum* from Mamut River, Poring. St. 42, SVL 23.2 mm.

The adult and immature females measure: SVL 28.9 and 15.5 mm; HW 0.339 and 0.400 of SVL; Tibia L 0.540 and 0.530 of SVL, respectively.

The body size in the larger female approximates to that in females examined by INGER (1966); sexual maturity in the females of this species is considered to be attained when they reach about 29 mm in SVL.

The adult female collected in late March had ovaries with a few small pigmented ova and the smaller female had small unpigmented ovaries.

Amolops cavitympanum **BOULENGER** Fig. 24

Mamut River, Poring, 550 m, 2 larvae (OMNH unnumbered).

The younger tadpole in stage 31 measures: BL 18.6 mm; Tot L 47.4 mm; Tail L 1.55 of BL. The older one in stage 42 measures: SVL 23.2 mm; Tot L 49.2 mm; Tibia L 12.6 mm. The labial teeth are III:8+8/1+1:V in both specimens.

The two tadpoles have undivided upper beak, which differenciates larval *cavitympanum* from other Bornean *Amolops* tadpoles (INGER, 1966). They well agree with the description of *cavitympanum* in every respects.

Metamorphosing older tadpole lacks outer metatarsal tubercle and its toes are fully webbed to disks.

These tadpoles were collected in February from a wide river with strong currents.

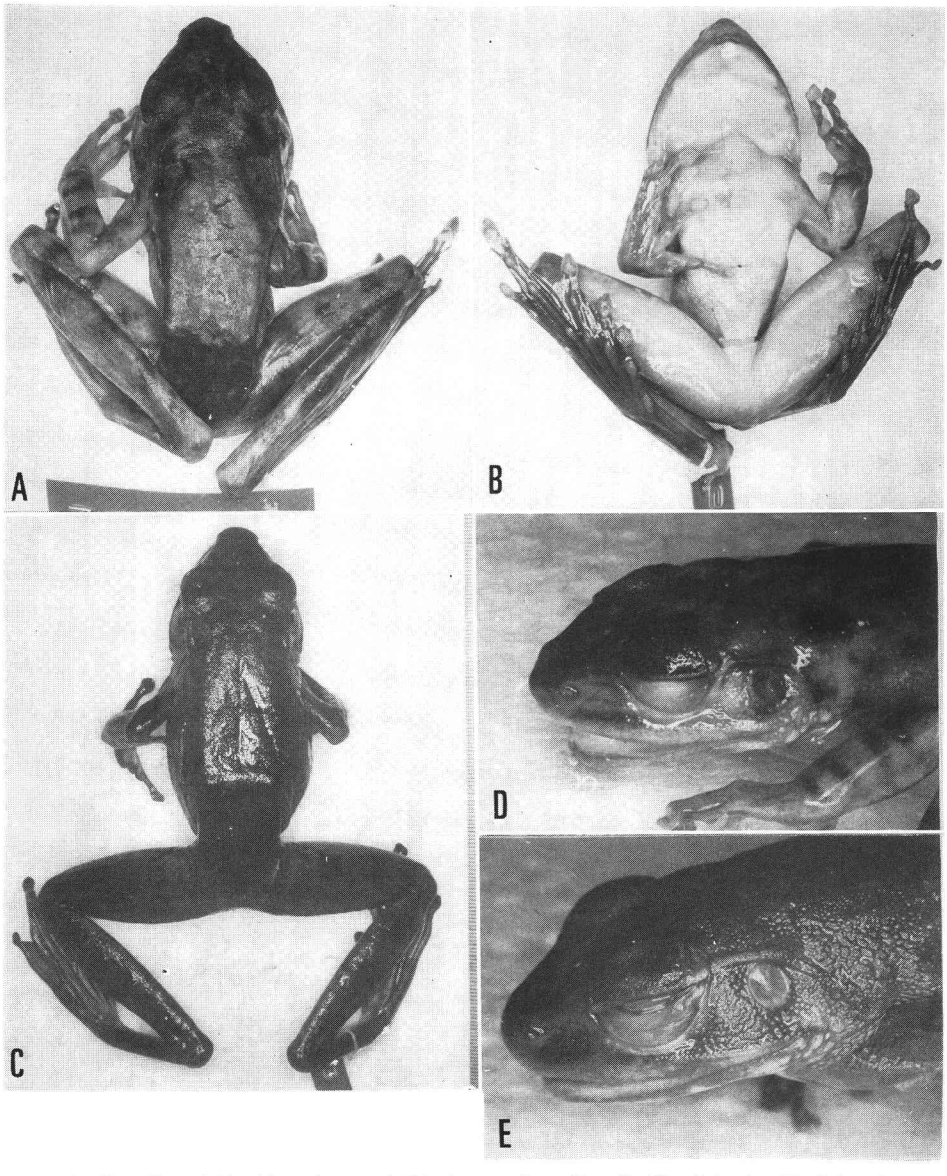

Fig. 25. Dorsal (A, C) and ventral (B) views and profiles (D, E) of *Amolops kinabaluensis* from Silau Silau Stream, KNP. A, B, D, immature male, SVL 57.8 mm; C, E, female, SVL 93.2 mm.

Amolops jerboa (GÜNTHER) Fig. 28

KNP Headquarters, 1665 m, 1 female; Liodan River, Bundu Tuhan, 990 m, 2 males; Murok midway betw. Ranau and Telupid, ca. 500 m, 1 male.

The three males with nuptial pads and vocal sacs measure: SVL 34.2–35.6 mm; HW 0.339–0.354 of SVL; Tibia L 0.699–0.708 of SVL. The female measures: SVL

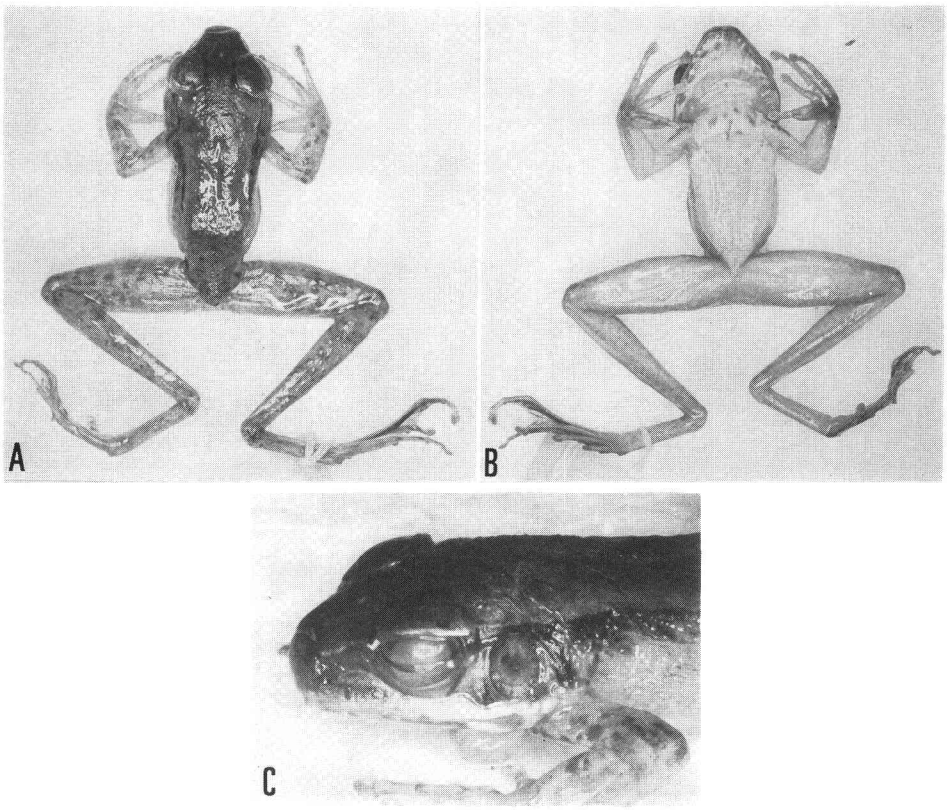

Fig. 26. *Amolops* sp. A, from Liwagu River, KNP, male, SVL 32.8 mm. A, dorsal view; B, ventral view; C, profile.

65.6 mm; HW 0.343 of SVL; Tibia L 0.709 of SVL.

Males were collected by day either among pebbles and rotten twigs on rocks in a river (WT 20.6 C) or under stones on a shaded mossy bank of the river. Several males were seen clinging on a rocky bank of a clear stream in jungle forest by day.

The female collected in mid March, containing enlarged pigmented ova, was found at night along a stream in mixed oak forest.

Amolops kinabaluensis INGER Figs. 25, 28

Silau Silau Stream, KNP, 1620 m, 2 immature males + 1 female; Gunong Alab, 1600 m, 1 female (OMNH unnumbered).

The immature males measure: SVL 54.0 and 57.8 mm; HW 0.374 and 0.367 of SVL; Tibia L 0.659 and 0.678 of SVL, respectively. The two females measure: SVL 83.6 and 93.2 mm; HW 0.356 in each; Tibia L 0.656 and 0.649 of SVL, respectively.

Two immature males lacked vocal sac openings and nuptial pads, although the larger male is almost the same in body size with the smallest mature male (SVL 58.1 mm) described in INGER (1966). They have relatively larger tympanum (0.073–0.074

of SVL) than in the males of *kinabaluensis* described by Inger (0.058–0.065 of SVL). Otherwise, the two specimens agree with the description of *kinabaluensis*.

The females collected in mid March and in mid December had large ova with pigmented hemisphere, about 2 mm in diameter.

Three from Kinabalu were collected at night on the bank of a shaded stream, about one meter above the ground level. One female from Mt. Alab was collected from roadside wet place in logged forest.

***Amolops* sp. A** Figs. 26, 28

Liwagu River, KNP, 1500 m, 1 male.

SVL 32.8 mm; HW 0.402 of SVL; Tibia L 0.720 of SVL.

The male with a pair of vocal pouches and well developed nuptial pad, has the blunt snout unlike known members of Bornean *Amolops* (Fig. 28). It has distinct tympa-

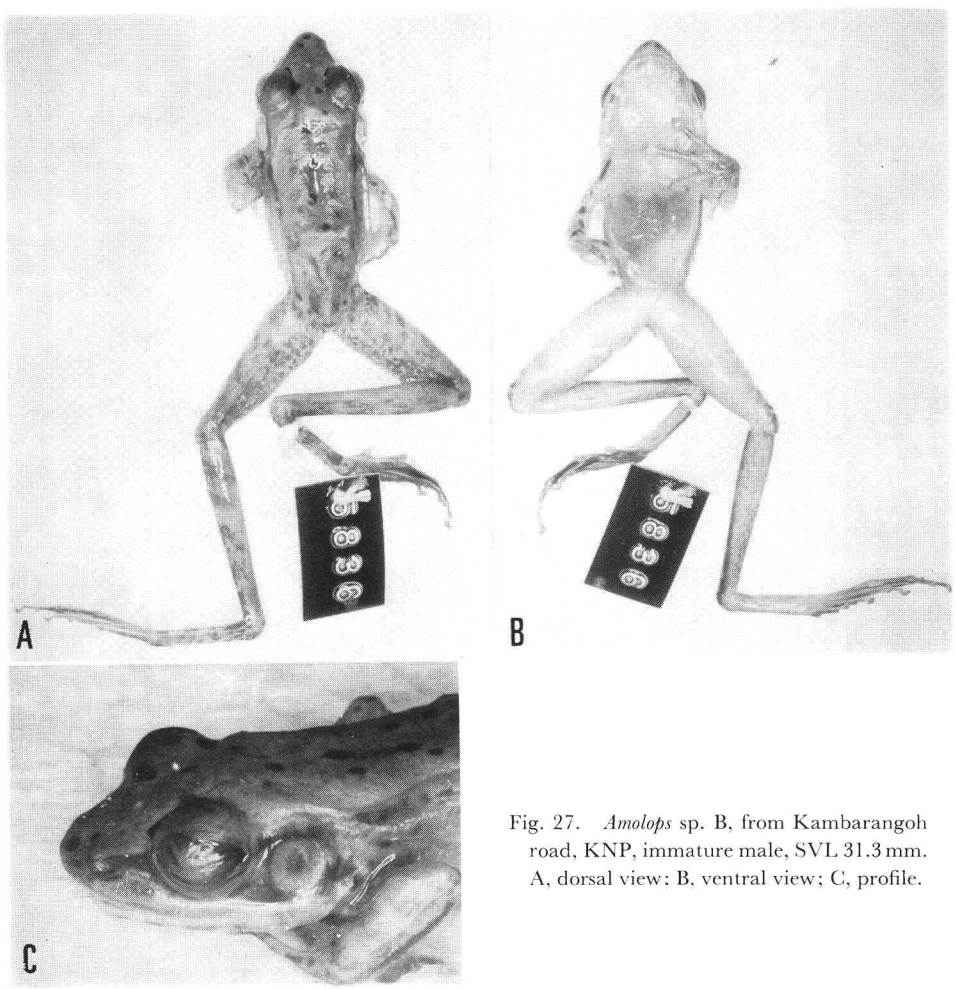

Fig. 27. *Amolops* sp. B, from Kambarangoh road, KNP, immature male, SVL 31.3 mm. A, dorsal view; B, ventral view; C, profile.

num differing from *A. cavitympanum*. It resembles *A. jerba* in the body size and in the presence of outer metatarsal tubercle, but differs from the latter in the following characteristics: fourth toe with two phalanges free of web, head wide (ratio to SVL out of the range covered by *A. jerboa*), dorsum covered with small granules but not shagreened, nuptial pad large, extending to disk on the first finger as a narrow fringe. From *A. kinabaluensis*, this male is easily differentiated by the fourth toe webbing (full webbing in *kinabaluensis*), presence of outermetatarsal tubercle, wider head, longer hindlimb, and much smaller body size. It resembles "sp. B", described in the following lines, in the poor development of the web, but differs from "sp. B" in the presence of outer metatarsal tubercle.

The male was found hopping in a rainy daytime in mid March along grassy bank of a clear stream.

***Amolops* sp. B** Figs. 27, 28

Kambarangoh road, KNP, ca. 1700 m, 1 immature male + 1 immature female.

The immature male and female measure: SVL 31.3 and 28.7 mm; HW 0.380 and 0.376 of SVL; Tibia L 0.728 and 0.679 of SVL, respectively.

The two specimens have superficial tympanum and are different from *A. cavitympanum*. They resemble in body shape with *A. jerboa*, but the web extention on the fourth toe is in the same condition as in "sp. A", i.e. two phalanges are free of web in these specimens. The body size of the immature male (31.3 mm) falls in the range of mature *A. jerboa* males (30.9–53.0 mm, INGER, 1966: 265), but the nuptial pad and vocal sacs are absent in this male. Further, these specimens lack outer metatarsal tubercles, sharply contrasted with *A. jerboa* and *A.* "sp. A". Although *A. kinabaluensis* lacks outer metatarsal tubercle, it has full webbing on the fourth toe. The extention of webbing is determined by the time of metamorphosis in *Amolops* tadpoles (INGER, 1966: 271), therefore the conditions found in spp. "A" and "B" are not attributed to growth variation.

The two specimens were collected by day in mid August under stones in roadside ditches in logged forest.

Amolops species from extrateritorial localities have not been examined so far and pertinent identification of these specimens, as well as "sp. A", will be made in future.

There are little possibilities, however, that species "A" and "B" are parental species of either of the three Bornean forms of larval *Amolops*, whose parents are unknown (larvae "A", "B", and "D" of INGER, 1966), since these larvae have fully webbed toes in older stages of development.

***Polypedates leucomystax leucomystax* (BOIE)** Fig. 29

Papar, 10 m, 1 male; Ranau, 504 m, 11 males + 6 females; Marakau, near Ranau, 480 m, 2 larvae + 1 egg mass; Poring Hot Spring, 555 m, 1 female; Kundassan, 1440 m, 1 egg mass; Kambarangoh road, KNP, 1680 m, 1 egg mass; Sepilok Forest Reserve, 50 m, 1 female + 16 larvae + 1 egg mass; Utara Road, Sandakan, 7 males + 6 females.

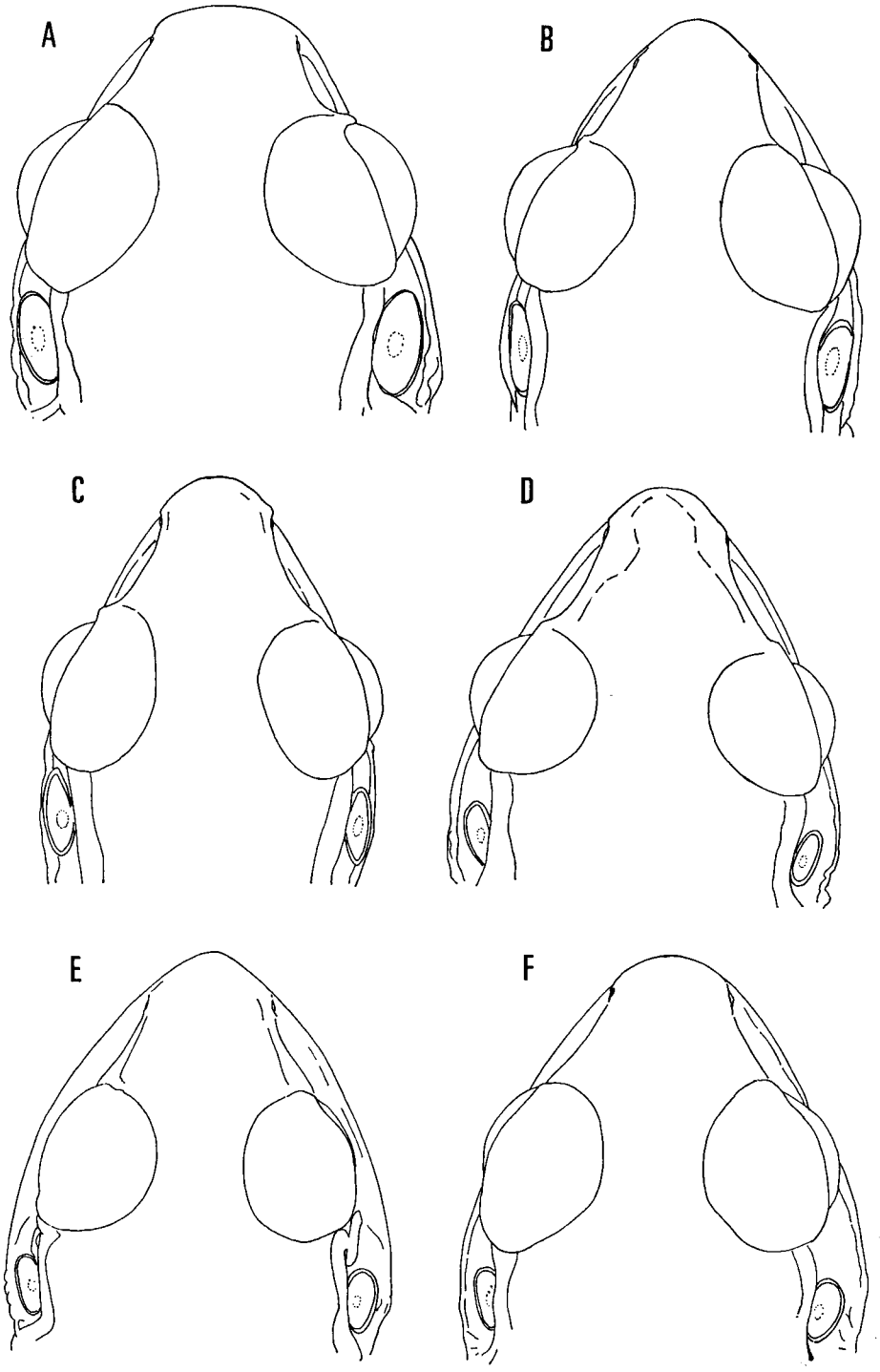

Fig. 28.

Table 25. Comparisons of body size and proportions of *Polypepedates leucomystax* from western- and eastern-North Borneo.

	N	SVL		Head width	
		Range	Mean±SD	Range	Median
Western					
♂ Ad.	11	35.8–43.6	41.0±2.2	.294–.327	.311
♀ Ad.	7	49.8–60.8	57.5±3.8	.301–.336	.324
Eastern					
♂ Ad.	7	43.2–51.4	48.3±3.1	.282–.312	.299
♀ Ad.	7	61.3–71.8	66.5±3.2	.298–.328	.315

	Tibia length		Disk on 3rd Finger		Tympanum diameter	
	Range	Median	Range	Median	Range	Median
Western						
♂ Ad.	.485–.559	.496	.039–.052	.043	.062–.085	.073
♀ Ad.	.497–.601	.525	.043–.051	.047	.065–.087	.073
Eastern						
♂ Ad.	.492–.518	.502	.042–.056	.047	.066–.079	.069
♀ Ad.	.491–.539	.506	.046–.054	.051	.059–.078	.072

INGER (1966) discussed the taxonomic relation of Bornean *Rhacophorus* (=*Polypedates*, following the definition of LIEM, 1970) *leucomystax* complex and distinguished northeastern population as a distinct species, *Rh. macrotis*, from western *leucomystax*. Samples from Sandakan, however, except their larger body sizes (Table 25), agree with those from western Sabah in having the cahracteristics of *P. leucomystax*; vocal

Table 26. Measurements (in mm) and ratios of larvae of *Polypedates leucomystax*.

St.	N	Body length		N	Total length		N	Tail L/BL	
		Range	Mean±SD		Range	Mean±SD		Range	Median
26	4	5.4–6.2	5.9±0.4	4	14.2–15.4	14.7±0.6	4	1.31–1.63	1.52
27	3	7.9–8.4	8.2±0.3	2	17.5–20.2	18.9	2	1.22–1.41	1.31
28	2	8.3–8.4	8.4	2	20.8–21.2	21.0	2	1.51–1.52	1.52
29	4	9.8–10.8	10.3±0.4	4	24.8–25.8	25.1±0.5	4	1.38–1.53	1.41
31	2	11.2–13.2	12.2	2	24.2–31.2	27.7	2	1.16–1.36	1.26
33	1		10.4	1		29.7	1		1.41
35	1		13.8	1		33.2	1		1.76
41	1		15.3	1		42.2	1		1.86

Fig. 28. Dorsal views of head of four Sabahan *Amolops* species. A, *A.* sp. A, male, HW 13.2 mm; B, *A.* sp. B, immature male, HW 11.9 mm; C, D, *A. jerboa* (C, male, HW 12.2 mm; D. female, HW 22.5 mm); E, F, *A. kinabaluensis* (E, immature male, HW 21.2 mm; F, female, HW 33.2 mm).

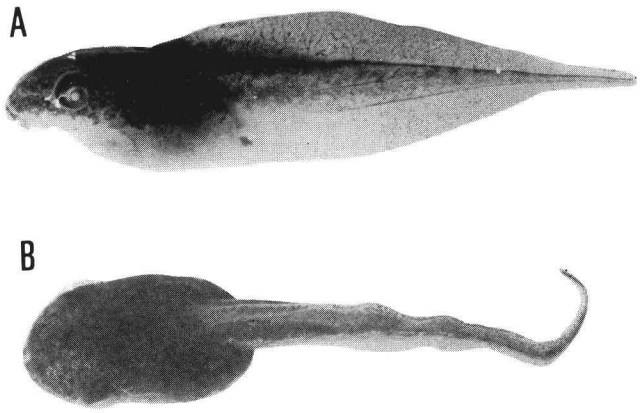

Fig. 29. Lateral (A) and dorsal (B) views of tadpole of *Polypedates leucomystax leucomystax* from Marakau near Ranau, St. 33, Tot L 29.7 mm.

sacks present in males, four narrow stripes on dorsum present, and no broad dark temporal band.

At Ranau, callings were heard at night in temporary pools on grassland in mid March. A female captured spawned ivory white egg mass. Several *R. erythraea* were found in the same pools. Males of *P. leucomystax* were hardly detected since they were calling under stones and among grasses at the edge of the pools (GT 27 C).

Females collected in August and December had convoluted oviducts but their ovaries were small.

INGER (1966) could not examine Bornean larvae and cited previous author's (e.g. ALCALA and BROWN, 1956) descriptions on extraterritorial populations. Both series of tadpoles from Marakau and Sepilok well agreed with these descriptions and hence are considered to larval *leucomystax*. Labial teeth formula of I:3—3/III and narrow tail tip (Fig. 29), found in these tadpoles, are characteristics distinguishing larval *leucomystax* from *macrotis* tadpoles.

Larvae were found swimming quietly in warm pools. A white-ivory egg mass was found on the grassy bank of the pool where two tadpoles were collected at Marakau. Two foam nests from Kinabalu are similar to those collected from lower elevations and are tentatively identified as *leucomystax* egg masses. One was found among stones in a ditch and the other was under a board at the edge of a temporary pool in logged forest.

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